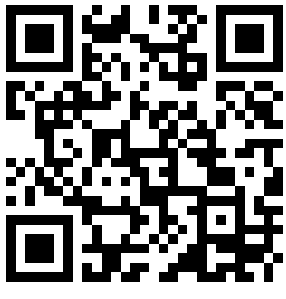
This is a reproduction of a library book that was digitized by Google as part of an ongoing effort to preserve the information in books and make it universally accessible.

Google™ books

https://books.google.com



Princeton University Library
32101 050973120

Digitized by Google

Library of
Princeton University.

Brackett Library

Palmer Physical Laboratory

Presented by
Stephen S. Palmer
David B. Jones
Thomas D. Jones

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

VOLUME XXIV.

FROM NOVEMBER 8, 1889, TO MAY 2, 1890.

(RECAP)

LONDON:
Printed and Published for the Proprietors by GEORGE TUCKER, at the Offices of "THE ELECTRICIAN," Salisbury-court, Fleet-street, E.C.

1890.

Digitized by Google

Digitized by Google

INDEX TO "THE ELECTRICIAN."

VOL. XXIV.

General Alphabetical Index.

Italic **figures denote that the subject matter is in the "Leading Articles" or in the "Editorial Notes."**

Abandonment of Metropolitan Electric Lighting Schemes, 565.
Abandonment of Proposed London Subway Railways, 283.
Abdank-Abakanowicz Arc Lamp, 376.
Académie des Sciences, The, 233, 488, 541.
Accident to the Electric Light in Vienna, 489.
Accidents to Linemen in New York, 198.
Accumulator, Payen, 233.
Accumulators, Gelatinous Electrolyte for, 613.
Accumulators, Robbery of, 610.
Accumulators, The Regulation of, in Electric Lighting: by G. B. Prescott, 42, 69.
Accumulators, The Theory of, 44.
Accumulators, Use of Cellu'oid in, 639.
Accumulators (*see also* Batteries, Storage).
Actino-Electric Effect of the Ultra-Violet Rays, 233.
Actino-Electric Phenomena, 363.
Actino-Electric Researches of Stoletow, 188.
ADDENBROOKE, G. L.
Electrical Engineering in America, 120, 148, 164.
Underground Mains, 260, 285, 313, 342, 367, 391, 413.
Aden, Severe Storms at, 489.
Adjuster, Telegraph Line, Delany, 152.
"Admiral Nakimoff," The Electric Light Installation on the, 56.
Afghanistan, The Telegraph in, 256.
Agir Motor, 56.
Agitation among Telegraph Clerks, 543, 641.
Agricultural Engineers' Association, 354.
Air Pump, Otto von Guericke's, 233.
Air Temperatures at Great Heights, Determination of, 82.
Alarm Advance Car, Electric, 83.
Alioth Dynamo, 5.
Alternating-Current Apparatus, Some Tests on the Efficacy of: by Dr. Louis Duncan and W. F. C. Hasson, 593.
Alsacienne Dynamo, Brush-holder of the, 138.
Alloys for Standard Resistances, 542.
Alternate-Current Patents, Edison, 629.
Alternate Currents, Some Peculiarities of: by Dr. W. E. Sumpner, 60.
Alternating *v.* Continuous Currents in Relation to the Human Body: by H. Newman Lawrence and Arthur Harries, M.D., 551 (*see also* 539, 555, 563, 581, 604, 611, 629).
Alternating System, Progress of the, in America, 250
Aluminium, Method of Production of, The Pittsburg Reduction Company's, 74, 515.
Alzano (Italy), Alternating-Current Motor at, 639.
Amalgamated Storage Battery Plates, 185.
American Bell Telephone Company, The United States Government Suit against the, 41, 250.
American Electrical Apparatus in the Transvaal, 28.
American Magazines, Electrical Articles in the, 41.
American Opinion on the Deptford Central Station, 352.
American Street Railway Association, Meeting of the, 18.
Ammeter, Compass, Moseley, 483.
Ampere Gauge, 187.
Antilles, the, and Cayenne, Proposed Cable between, 134.
Apparatus, Electrical, for Determining Melting Points, 333.
Arc Lamp, Nine Years with the: by M. D. Law, 504.
Arc Lamp Patent, The "Double-Carbon," 250.

Arc Lamps—
Abdank-Abakanowitz, 376.
Carbon Disc, 386.
Kent, 100.
Lacassagne-Thiers, 45.
Schneider, 471.
Solignac, 330.
Stocher-Sedlaczek, 277.
Westinghouse, 273.

Arc Lamps, Lighting Power of, 9.
Arc Light Formula, Gerard's, 336.
Archangel and St. Petersburg, Proposed Electric Railway between, 363.
Archer Electrical Conduit, 613.
Armature Reactions, Theory of, in Dynamos and Motors: by James Swinburne, 373, 397 (*see also* 335).
Armatures, Compound Conductors for, 507.
Armatures, Winding of, 138, 174.
Aron Meter, Report on: by Gisbert Kapp, 351 (*see also* 335, 379).
Artificial Gutta-Percha, 639.
Artistic Electric Light Fittings, 628.
Asphalte, Mineral Indiarubber, 4.
Association of Metropolitan Electric Lighting Companies, Proposed, 283.
Association of Municipal Corporations, The, and Electric Lighting, 465.
Associations, Electric Light, Establishment of, in America, 352.
Atlantic Cable, Proposed New, to Canada, 309.
Atmospheric Electricity and the Use of Sir William Thomson's Portable Electrometer, Notes on: by C. Michie Smith, 66.
Atmospheric Electricity, Curious Effect of, upon an Underground Telegraph Wire, 446.
Atomic Weights and Magnetic Properties, Relations between, 337.
Attachés, Technical, 159.
Audio Telephone Mouthpiece, 534.
Australasian Telegraph Statistics, 310.
Australia, Progress of the Electric Light in: by E. J. Erskine, 592.
Austria, Telephonic Development in, 629.
Automatic Electric Lamps, 183.
AYRTON, Prof. W. E., MATHER, T., and SUMPNER, Dr. W. E.
Galvanometers, 348.
Ayrton and Perry's Twisted Strip Voltmeter: by Prof. J. Perry, 647.
Back Blocks, 405, 458.
Badt's Handbook of Incandescent Wiring, 45.
Bakery, An Electrical, 488.
Balance, Electrostatic, 30.
Barking-road, Electric Traction on the, 31, 457.
Barraclough's Wire Covering Machine, 530.
Bathurst Improved Back Block, 405.

Batteries (Primary)—
Clark Standard Cell, 356: by Prof. H. S. Carhart, 271, 643; by Lord Rayleigh, 285; by H. H. Hoffert, 327.
Coad, 317.
Dry, 185, 365, 490.
Edison, 158.
Gülcher Thermo, 516.
Hussey Bluestone, 83.
Imchenetzki, 589.
Mehner Dry, 365.
Tatlow, 543.
Weymersch, 454.

Batteries (Storage)—
Eickemeyer, 135.
McLaughlin, 388.
Marx, 542.
Novel, A, 531.
Payen, 233.
Pollak, 515, 563.
Simple, A, 590.

Battery Boxes, Recipe for Making, Watertight, 542.
Baudot Telegraph, 232.
Bavaria, The Telegraph in, 233.
Baxter Motor, New, 105, 125.
Bearers, Steel, Use of, for Overhead Wires, 20.
BELL, Dr. LOUIS.
Electric Motors in General Railway Work, 575, 600.
Test of the New Sprague Street Railway Motor, 247.
Ben Nevis Observatory, Lightning at the, 262.
Benest Submarine Cable Grapnel, 638, 649.
Berlin, Electric Traction at, 541.
Berlin and Vienna, Telephone Line between, 337.
Bermudas-Halifax Cable, The, 3, 282, 337, 590.
BERNSTEIN, ALEXANDER.
Distribution of Electric Energy by means of Constant Current, 84, 107, 112.
Bernstein Automatic Cut-Out for Series Incandescent Lamps, 85.
Bernstein Incandescent Lamp Holder, 86.
Bernstein Regulator for Constant-Current Working, 85.
Bernstein System, 105.
BIDWELL, SHELFORD.
Effect of Tension upon Magnetic Changes of Length in Wires of Iron, Nickel, and Cobalt, 649.
Electrification of a Steam Jet, 149, 227 (*see also* 174).
Bills in Parliament, 284, 310, 414, 440, 466, 490, 515, 639, 651.
Binswanger's High Insulation Ceiling Roses, 380.
Birmingham Exhibition, 2, 88, 412.
Birmingham and St. Helen's, Telephonic Communication between, 336.
Bismuth in the Magnetic Field, 362.
Blackpool Tramway, The, 107.
Blamire's Patent Indicating Apparatus, 433.
Bleaching, Electric, 542.
"Blocking Orders," 207, 335.
Bluestone Battery, Hussey, 83.
BLYTH, Prof. JAMES.
Electrical Oscillation Detector, 442.
Board of Electrical Control in New York, Proposed New, 325.
Board of Health in New York, The, and High-Tension Circuits, 325.
Board of Trade, The, and Electric Lighting Orders, 641.
Board of Trade Electric Light Regulations, Draft, 255, 275.
Board of Trade, List of Intended Applications to, for Provisional Orders, 117, 120, 159, 216.
Board of Trade, Provisional Orders and Licences granted by the, during 1889, 215.
Board of Trade Report on Electric Lighting Bills and Orders of 1890, 466.
Borneo-Singapore Cable, Proposed, 160.
Boston (U.S.A.) Electric Light Committee, Wiring Recommendations of the, 273.
Boston (U.S.A.) Electric Lighting Contract, 325.
Boston, Electric Traction at, 353.
Boston, Overhead Wires at, 226.
Boston, The Fire at, 105, 181, 198, 226.
Bradford Scientific Association, 565.
Brain Work and Manual Labour, 514.
Brake, Electric, Trials, 160.
BRAMWELL, SIR FREDERICK.
Electric Welding, 624.
Brazil, The Rubber Monopoly in, 209, 232, 289.
Brazil, The Telegraph in, 489, 613.
Brazilian Government, The, and the Western and Brazilian Telegraph Company, 17, 96, 256.
Bremen Exhibition, 133.
Brighton, The Electric Railway at, 309.
Bristol University College, 564.
Bristol's Portable Electric Lamp, 581.
British Association Screw Thread, 3.
BROOKS, DAVID.
Underground Conductors, 87.
Brooks System, 79.
Brown, Harold P., and High-Pressure Currents, 2.
Brown System of Electrical Distribution, 80.
Brush Company's Dinner, 231.
Brussels Tramways, 232, 515.
Budapest-Vienna Telephone Trunk Line, 209.
Bulbs, Incandescent Lamp: Frosting, 364; Tinting, 231.
Buenos Ayres and Monte Video, Telephone Line between, 135.
Bunsen Cell, Employment of Chromic Acid in the, 21.
Burglar Alarm, 88.
Burglar Alarm, Jacobus Closed Circuit, 364.
Burmah, The Telegraph in, 541.
Buoys, Incandescent Lamps on, 185.
C. and C. Electric Ventilating Motors, 55.
Cable Interruptions, 107, 282, 309, 590.
Cable Laying, 75, 257, 284, 309.
Cable Rates: Henniker Heaton on, 385; Sir James Anderson on, 463.
Cable Repairs, 21, 232, 257, 336, 362.
Cable Street Railways *v.* Electric Street Railways, 325.
Callender Bitumen Company's Underground Mains, 391.
Callender-Webber Underground Mains, 392.
Canada, Electrical Activity in, 210.
Canadian Telegraphs, 56.
Carbon Deposit in a Blake Telephone Transmitter: by F. B. Hawes, 428.
Carbon Tests: by E. F. Peck, 470.
Carbon Disc Arc Lamp, 386.
Carbonic Oxide Indicator, 364.
Carbons, Electric Arc Light: by O. G. Pritchard, 492, 545, 563, 616.
CARBY, JOHN J.
New View of Telephone Induction, 122.
Cardew Earthing Device, 605.
CARHART, H. S.,
Improved Standard Clark Cell with Low Temperature Coefficient, 271, 643.
Car Service, Electric Practical Points in: by O. T. Crosby, 213.
Cayenne and the Antilles, Proposed Cable between, 134.
Ceiling Roses, Binswanger's, 380.
Celluloid, Use of, in Accumulators, 639.

Central Lighting Stations—
Berlin, 388.
Brighton, 308.
Brooklyn, 227.
Brünn, 488.
Copenhagen, 379.
Dockyards, 135, 257.
Hanover, 389.
Italian, 515.
Johannesburg, 133.
Magdeburg, 387.
Paris, 99, 107, 133, 274, 326, 378, 629.
Pont-de-Vaux, 338.
Rathbone-place, 237.
St. James's and Pall Mall Electric Light Company's, 287.
Salzburg, 337.
Sardinia-street, 309.
Sundsvaal, 378.
United Kingdom, List of, in the, 222, 232, 245.

Central London Electric Railway, 55, 80, 124, 183, 282, 338, 364, 388, 412, 439, 465, 611, 627, 651.
Central Telegraph Staff, Meeting of the, 183.
Ceresin, Electrostatic Phenomena presented by, 353.
Ceuta and Tarifa, Proposed Cable between, 412.
Challenge to the Edison System 250.

24197=cop.2
Digitized by Google

CHALON, M.
Use of Electricity in Mines, 375.
Charlesworth, Hall, and Co.'s Electric Light Engines, 329.
Chevrant Paper Mills, Transmission Plant at the, 210.
Chicago Auditorium, Lighting of the, 378
Chili, The Telegraph and the Telephone in, 489.
Chilian Import Duties, Repeal of, 3.
China, Electricity in, 299.
China and India, Telegraphic Communication between, 489.
Chlorine Water, Rate of Decomposition of, by Light: by Dr. G. Gore, 114.
Chromic Acid, The Use of, in the Bunsen Cell, 21.
Chronological Chart, A., 640.
Church Lighting, 282, 309, 438, 613.
Church Organs, Electric Power for, 151.
Cincinnatti Inclined Plane Electric Railway, 311.
Circuit Breaker, Young, 378.
City and Guilds of London Institute, 160.
City and Guilds Old Students' Association Soirée, *182*.
City and Guilds Technical Education, *36*, 75.
City Notes, 23, 51, 77, 103, 129, 155, 179, 205, 229, 253, 279, 305, 333, 359, 383, 409, 435, 461, 483, 511, 537, 561, 585, 609, 635, 661.
City and Southwark Subway, 183, 458, 488, 506, 515, *638*.
Civil Engineers, Institution of, 82, 208, 282.
Civil and Mechanical Engineers' Society, 82.
Clark Standard Cell: by Prof. H. S. Carhart, 271, 643; by Lord Rayleigh, 285; by H. H. Hoffert, 327.
Clermont-Ferrand Electric Tramway, 233.
Clock, Electric, An Alternate-Current, 387.
Clothworkers' Company Scholarship, Award of the, 209.
Coad Battery, 317.
Coast Communication, Electrical, *208*.
Code, Government Telegraph, for India, 134.
Co-efficient of Self-Induction of a Single Circular Loop, *611*, 631.
College Lighting, 337.
Colonial Telegraph Statistics, 363.
Coloured Flames, Conductivity of, 364.
Column Printing Telegraph Patents, 184.
Commercial Cable Company, Mr. Mackay and the Staff of the, 232.
Commissioners of Sewers, 387.
Compactum Feed Water-Heater, 459.
Compagnie Continentale Edison, 480.

COMPANIES' MEETINGS, REPORTS, DIVIDENDS, &c.

(Abbreviations:—Div., Dividend; Mtg., Meetings of Shareholders; Rev., Revenue; Rpt., Reports of Directors.)

American Bell Telephone Company—Rev., 537; Div., 333.
Anglo-American Telegraph Company—Div., 305, 561; Rpt., 332; Mtg., 355.
Anglo-Portuguese Telephone Company—179; Div., 537; Rpt., 660.
Australasian Electric Light, Power, and Storage Company—333.
Bedford Electric Lighting Company—Mtg., 607.
Berliner Electricitatswerke—28.
Blackpool Electric Tramway Company—Rev., 103; Mtg., 129.
Brazilian Submarine Telegraph Company—609, 639; Rev., 23, 51, 77, 103, 129, 155, 179, 205, 229, 253, 279, 305, 333, 359, 383, 409, 425, 461, 485, 511, 537, 561, 585, 609, 635, 661; Div., 485; Rpt., 659; Mtg., 21.
Brighton and Hove Electric Light Company—Rpt., 584; Mtg., 659.
British Guiana Electric Lighting and Power Company—661.
Brush Electrical Engineering Company—103, 205; Div., 383, 461; Mtg., 102.
Chelsea Electricity Supply Company—Mtg., 382, 407.
China and Japan Telephone Company—Mtg., 658.
City of London and Southwark Subway Company—Rpt., 358; Mtg., 407.
Commercial Cable Company—229; Div., 561.
Consolidated Telephone Construction and Maintenance Company—Div., 661.
Continental India Rubber Works—Div., 333.
Continental India Rubber and Gutta Percha Company—Div., 609.
Continental Metropolitan Tramways Company—Mtg., 607.
Crompton and Co.—537; Div., 51.
Cuba Submarine Telegraph Company—Rev., 23, 129, 253, 359, 461, 561; Div., 305; Mtg., 357.
Direct Spanish Telegraph Company—Rev., 23, 129, 253, 359, 461, 585; Div., 409; Rpt., 485; Mtg., 534.
Direct United States Cable Company—439; Div., 253, 561; Rpt., 279; Mtg., 303.
Eastern Telegraph Company—305, 613; Rev., 23, 129, 253, 359, 461, 561; Div., 179, 537, 609; Mtg., 277, 302.
Eastern Extension, Australasia, and China Telegraph Company—179, 253, 279, 561, 585; Rev., 23, 129, 359, 461; Div., 537; Rpt., 608; Mtg., 632.
Eastern and South African Telegraph Company—23, 54, 205, 305.
Edison-Swan United Electric Light Company—Div., 333.
Electric Construction Corporation—23, 155.
Electric Welding Syndicate—585.
Electricity Supply Company for Spain—103, 383.
Elmore's Patent Copper Depositing Company—359; Div., 585.
Elmore's Foreign and Colonial Patent Copper Depositing Company—103, 279.
Evered and Co.—485.
Exeter Electric Light Company—Mtg., 485, 561.
Farcham Electric Light Company—Mtg., 585.
Fowler-Waring Cables Company—129; Mtg., 154.
Ganz and Co.—Div., 561.
Globe Telegraph and Trust Company—Div., 253, 537.
Great Northern Telegraph Company—Rev., 23, 129, 253, 359, 461, 485, 585; Div., 179; Rpt., 634; Mtg., 657.
Greenwood and Batley—Div., 51.
Gülcher (New) Electric Light and Power Company—511.
Halifax and Bermudas Cable Company—205, 229.
House-to-House Electric Light Supply Company—Rpt., 660.
Incandescent Gas-Light Company—103.
India-Rubber, Gutta-Percha, and Telegraph Works Company—Rpt., 359; Mtg., 406.
Indo-European Telegraph Company—Rpt., 609; 656.
Liverpool Electric Supply Company—Mtg., 484.
London Electric Supply Corporation—Mtg., 558.
London Platino-Brazilian Telegraph Company—Mtg., 661.
Manitoba Electric and Gas Light Company—179.
Maxim-Weston Electric Company—435; Mtg., 177.
Metropolitan Electric Supply Company—Rpt., 173; Mtg., 202.
Montevidean and Brazilian Telegraph Company—Mtg., 607.
Montevideo Telephone Company—Div., 609.
National Telephone Company—103, 155, 205; Rev., 129.
New Australian Electric Company—Mtg., 510.
Newcastle and District Electric Lighting Company Mtg., 536.
Newcastle Electric Supply Company—Mtg., 511.
Nippon Electric Light Company—27.
Northern Electric Wire and Cable Manufacturing Company—Mtg., 433.
North Metropolitan Tramways Company—Mtg, 359.
Notting Hill Electric Lighting Company—233, 279, 537; Mtg., 484.
Oriental Telephone Company—Div, 561; Rpt., 634; Mtg., 658.
Postal Telegraph and Cable Company—583.
Phonopore Syndicate—Mtg., 205.
Reuter's Telegram Company—585; Rpt., 609; Mtg., 634.
Rochester, Chatham, and District Electric Lighting Company—Rpt., 155.
Schanschieff Electric Battery Syndicate—253, 333.
Schooling and Co.—Div., 537.
Shanghai Electric Company—Div., 383.
South of England Telephone Company—Div., 23.
Spanish National Submarine Telegraph Company—103.
Spiel's Patent Petroleum Engine Company—Mtg., 229.
Submarine Cables Trust—561; Rpt., 661.
Submarine Telegraph Company—Mtg., 606.
Swan United Electric Light Company—Div., 661; Rpt., 23; Mtg., 49.
Taunton Electric Lighting Company—Mtg., 383.
Telegraph Construction and Maintenance Company—435; Rpt., 435; Mtg., 460.
Telephone Company of Austria—179; Div., 561.
Telephone Company of Egypt—Rpt., 511; Mtg., 536.
Telephone Company of Ireland—Rpt., 635; Mtg., 657.
Telephone Company of Rio de Janeiro—82.
United River Plate Telephone Company—485, 537; Div., 229; Mtg., 252.
United Trust Company of New York—359.
Victorian Schanschieff Electric Light and Power Company—537.
West African Telegraph Company—Div., 205.
West Coast of America Telegraph Company—Rev., 23, 129, 253, 359, 461, 561; Div., 229.
West India and Panama Telegraph Company—Rev., 23, 77, 129, 179, 253, 305, 359, 409, 461, 511, 585, 635; Div., 609; Rpt., 22, 659; Mtg., 48.
Western and Brazilian Telegraph Company—17; Rev., 23, 77, 103, 129, 155, 179, 205, 229, 253, 279, 305, 333, 359, 383, 409, 435, 461, 485, 511, 537, 561, 585, 609, 635, 661; Div., 51, 609; Rpt., 22, 659; Mtg., 46.
Western Counties and South Wales Telephone Company—305.
Western Union Telegraph Company—561; Div., 485.
Westminster Electric Supply Corporation—155, 485, 537; Mtg., 459, 537.
Winfield's (Limited)—383.
Woodhouse and Rawson United—23, 51; Div., 305; Mtg., 50.

Companies, New, Registered in 1889, Statistics of, 225, 282 (*see also* New Companies' List on page 7).

Companies Share List, 24, 52, 78, 104, 130, 156, 180, 206, 230, 254, 280, 306, 334, 360, 384, 410, 436, 462, 484, 512, 538, 562, 586, 610, 636, 662.
Companies Wound-up in 1889, 225.
Comparison, A, between the Continental, American, and English Dynamo-Electric Machinery: by Albion T. Snell, 5, 57, 138.
Compass, A Recording, 234.
Compass, The Mariner's, 29, 566.
Competition, Electric Meter, 232, 556.
Competitions, Electrical, 388, 565, 639.
Conductors, Heating of, by Electric Currents: by A. E. Kennelly, 142, 169, 194; by H. Human, 199.
Conductivity, Electrical, of Saline Solutions, 4.
Conductivity of Metals for Heat and Electricity, *336*.
Conductivity of Various Metals, Alteration in the, after a Lengthened Exposure to a High Temperature, 310.
Conduits, Electrical, 29, 613.
Conference, Maritime, at Philadelphia, 3.
Connector, Electric Light Cable, Seely, 517.
Co-Operative Stores, The Electric Light at, 439.
Co-Operative Telephones, 56, *80*, 201.
Constant-Current Transformer with Wattmeter attached, 113.
Continuous Currents from Alternating Currents, Methods of Obtaining, 42, *55*, *106*, 125.
Copper and the Electric Light, 108.
Copper Duty, Agitation for the Repeal of the, in America, 352.
Copper Market, The, 3, 81, 108, 209, 439, 540, 590.
Copper, Tempered, for Electrical Work, 414.
Cost of Electric Traction, *361*, 379, 457, 480, 506.
Costa Rica Cables, Concession for, 4.
Costly Telegram, A, 336
Coulon, M., Resignation of, 282.
Counter Electromotive Force of the Voltaic Arc, *303*, 326.
Country House Lighting, 387, 489.
Crawford, Lord, and the London Electric Supply Corporation, 438.
Crompton System of Underground Mains, 342.
CROSBY, O. T.
Practical Points in Electric Car Service, 213.
Cryolite, Electrolysis of: by W. Hampe, 234.
Curious Treatment of an Electric Meter, 135, 199.
Current Curve, Street Railway, 625.
Curve Plotting by Photography, *362*.
Customs Free List in Natal, An Addition to, 3.
Cut-Out, Bernstein Automatic, for Series Incandescent Lamps, 85.
Dangers of Electricity, The, 184.
Data, Electrical, Collection of, *307*.
Data, Electric Traction, Demand for, 403.
Davy Medal, Award of, 256.
Deaths from Electric Currents, *157*, 613.
Deep Sea Fishing by Means of the Electric Light, 235.
Delany Telegraph Line Adjuster, 152.
Demagnetising Watches, Apparatus for, 438.
Denmark, The Telegraph in: by Carl V. Hansen, 429.
Deptford, The Position of Affairs at, *539*.
Deptford Central Station, American Opinion on the, 352.
Derbyshire, The Telephone in, 541.
Deterioration of Insulation, 613.
Development of Electric Traction, 226, *572*.
Dewey Car Device, *486*.
Dinner of the Institution of Electrical Engineers, 12.
Disc Winding, 140, 174.
Dielectric Constants, Determination of, by Means of the Telephone, 83.
Dielectric Media, Influence of, on Electric Forces, 56.
Distillery, An Electric Tramway in a, 82.
Distribution of Electric Energy by Means of Constant Current: by Alexander Bernstein, 84, 107, 112.
Distribution of Power by Constant Circuit: by Elmer A. Sperry, 431.
Disturbances on Telephone Circuits: by Arthur E. Cotterell, 83.
Dockyard Central Lighting Stations, 135, 257.
Domestic Telephones, 370, 404, 432.
"Double-Carbon" Lamp Patent, 250.
Drugs, Administration of, by Electricity, 185.
Drummond Railway Signalling Device, 134.
Dry Batteries, 185, 365, 490
Dublin, An Electrical Inspector for, 362.
DUNCAN, DR. LOUIS, and HASSON, W. F. C.
Some Tests on the Efficiency of Alternating Current Apparatus, 593.
Duplex Telephone Systems, 287, 326.
Duriflex Packing, Moseley and Sons', 583.
Dynamo-Electric Machinery, A Comparison between the Continental, American, and English: by Albion T. Snell, 5, 57, 138.
Dynamo Insurance, 299.
Dynamo and Motor Design, Some Points in: by W. B. Esson, 423, 450, 474, 494 (*see also 411*, *545*, 532, 533, 583, 604, 631).
Dynamo Regulator, Heymann, 505.
Dynamometer, Waite Indicating, 531.

Dynamos—

Alioth, 5.
Mather and Platt 30-Unit Alternator, 262.
Miot, 57.
Parson and Co.'s, 405.
Polechko Disc, 546.
Reignier-Bary, 326, *464*, 480.
Sautter-Lemonnier, 6.
Single Magnet, 99.
Sperry, 57.
Thomson-Houston, 59.
Thury Six-Pole, 5.

Dynamos and Motors, Two-Pole, Continuous Output of: by Albion T. Snell, 469.
Dynamos, Series, Researches on the Reversal of Polarity of: by M. A. Witz, 618.
Earth, A Peculiar, 82.
Earth Currents, 339.
Earthing Device, Cardew, 605.
Earthquakes and Magnetic Disturbances, Relation between, 4.
East Reading Electric Railway, 431.
Eastern Telegraph Company's Special Line from London to Marseilles, 283
Edinburgh Exhibition, 3, 25, 27, 33, 79, 83, 96, 108, 133, 198, 221, 235, 284, 309, 362, 388, 465, 542, 564, 563, 589, *638*, *646*.
Edinburgh, Proposed Meeting of the Institution of Electrical Engineers at, 25.
Economic Ratio for a Traction System, 274, 403.
Edison Company's Underground System, 313.
Edison Patents, *157*, *463*, *487*, 629.
Edison and his Work, 365.
Edison General Electric Light Company, Progress of the, 338.
Edison, Mr., and Mining Investigations, 488.
Edison and Sprague Companies, Fusion of, *158*.
Edison Primary Battery, *158*.
Edison Station at Brooklyn, New, 227.
Edison Station at the Paris Exhibition, 99.
Edison System, Challenge to the, 250.
Eickemeyer Storage Battery, 135.
Eighteen Hundred and Eighty-Nine, *220*, *242*.
Electric Brake Trials, 160.
Electric Clock, An Alternate-Current, 387.
Electric Construction Corporation, New Works of the, at Wolverhampton, 28.
Electric Currents in the Skin, 339.
Electric Heater, Talmage, *487*.
Electric Lamp, Problems in the Physics of an: by Prof. J. A. Fleming, 393, 413, 417.
Electric Lamps, Automatic, 183.
Electric Launches, 459, 566.

Digitized by Google

Electric Light.

GREAT BRITAIN—

Aberdeen, 109, 160, 233, 541, 639.
Airdrie, 233.
Alnwick Castle, 55, 81.
Ayr, 54, 233.
Ballymena, 54.
Barnsley, 54, 81, 134, 257, 309, 412, 639.
Barrow, 109.
Bath, 107, 337, 489, *540*, 564.
Beckenham, 309, 565.
Belfast, 488.
Berwick, 282.
Birkenhead, 27, 160.
Birmingham, 232, 337, 540.
Bolton, 310, 465, 541.
Bournemouth, 27, 300.
Bracknell, 337.
Bradford, 159, 173, 258, 284, 364.
Bridlington, 232, 338, 387, 439.
Brighton, 201, 283, *309*, 365, 414, 440, 466, 482, 614, 653.
Bristol, 159, 310.
Bromley, 639.
Burnley, 2.
Burton-upon-Trent, 27.
Cambridge, 55, 159.
Canford House, 256.
Cardiff, 256, 640.
Carlisle, 82, 282, 564.
Chatham, 81, 640.
Chelmsford, 2, 282, 337, 438, 593, 639.
Cheltenham, 336.
Chester, 159.
Coatbridge, 613.
Coventry, 256, 309.
Croydon, 362, 412, 466.
Darlington, 81.
Devonport, 438.
Dover, 27, 159.
Drogheda, 488.
Dublin, 27, 160, 172, 337.
Dundee, 3, 54, 81, 107, 160, 233, 257, 282, 309.
Ealing, 81.
Eastbourne, 173, 233, 282, 589.
Edinburgh, 3, 27, 53, 309, 466, 515.
Ellenborough Colliery, 133.
Exeter, 3, 33, 133, 257, 613.
Fareham, 108, 282.
Fenton, 100.
Folkestone, 311, 337, 465.
Galway, 565.
Glasgow, 132, 232, 258, 283, 389, 490.
Gravesend, 27, 55, 282.
Great Yarmouth, 27.
Hamilton, 54.
Harrogate, 256.
Hastings, 3, 55, 173, 186.
Hawick, 640.
Hertford, 257, 589.
Hull, 3, 55, 257.
Ipswich, 159, 387, 564.
Keighley, 56.
Killarney, 283.
Keswick, 232.
Leamington, 27, 133, 257, 465.
Leeds, 173, 284, 309.
Levenshulme, 54.
Liverpool, 172.
London—
British Museum, 81, 310, 362.
Camberwell, 337.
City of London, 81, *107*, 109, 258, *308*, 337, 389 439, 523, 589, 641.
Fulham, 363, 404, 515.
Haymarket Stores, 413
Hornsey, 362.
Houses of Parliament, 81, 413.
Inner Temple, 413.
Islington, 338, 488.
Junior Army and Navy Stores, 439.
Kensington, 134, 514.
Lambeth, 337, 541.
Marylebone, 257, 565, 614
Notting Hill, 233.
Paddington, 257, 516, 614, 639.
St. George's, Hanover-square, 257, 362, 565.
St. George the Martyr, 540.
St. Giles, 257.
St. James, Westminster, 82, 133, 159, 337, 388, 540.
St. Luke's, 232, 309.
St. Margaret's and St. John's, 234.
St. Pancras, 201, *231*, 248, 364, 466.
Strand, 257, 488.
Wandsworth, 589.
West Brompton, 173, 251.
Westminster, 283.
Londonderry, 412.
Manchester, 160.
Morecambe, 81.
Newcastle-under-Lyme, 27.
Newcastle-upon-Tyne, 55, 81 107, 159, 257, 466, 516.
Northampton, 362, 540.
Northfleet, 232.
Nottingham, 27.
Oxford, 282, 464.
Padiham, 81.
Paisley, 2.
Plymouth, 588, 283, 438.
Portsmouth, 54, 159.
Preston, 540, 640.
Ramsgate, 3.
Reading, 257, 311, 465.
Richmond (Surrey), 283
Rochester, 159, 173, 282
St. Helen's, 81, 159.
St. Marychurch, 256.
Scarborough, 589.
Sevenoaks, 309.
Sheffield, 173.
Southampton, 256.
Southport, 362.

Electric Light (*continued*)—
South Shields, 133.
Stockton, 107.
Stoke-upon-Trent, 28.
Sunderland, 257, 639.
Surbiton, 81.
Swansea, 183.
Taunton, 3.
Thorverton Mills, 81.
Tipperary, 489.
Tiverton, 54.
Torquay, 232.
Tunbridge Wells, 363.
Tunstall, 27, 412.
Tynemouth, 81.
United Kingdom, Central Stations in the, 222, 232
Ventnor, 27.
Wales (South), 251.
Walsall, 256.
Walthamstow, 2.
Wednesbury, 54.
West Bromwich, 27.
Weybridge, 256, 363, 386, 590, 631.
Wigan, 2.
Wimbledon, 362, 413, 439.
Windsor, 27.
Woking, 283.
Wolverhampton, 3.
Worcester, 81.
Wrexham, 27, 337.
York, 27, 132, 439.

ABROAD—
Agra, 282.
Algeria, 134.
Altona, 209, 541.
Alzano (Italy), 183, 639.
Austria, 126.
Bamberg, 310, 639.
Berlin, 28, 82, 233, 336, 388, 541.
Blankenburg-a.-Harz, 465.
Boston (U.S.A.), 325.
Bremen, 133, 208.
Breslau, 132, 337, 541.
Brooklyn, 227.
Brünn, 488.
Brussels, 257, 564, 631.
Bucharest, 2.
Budapest, 388.
Cadiz, 282.
Carlsbad, 613.
Carrara, 388, 432.
Chicago, 378.
Cologne, 387, 412.
Copenhagen, 379.
Cordova, 589.
Craiova (Roumania), 565.
Dresden, 465.
Dunedin, 159.
Eisenach, 209.
Epernay, 516.
Farmsen (near Hamburg), 386.
Florence, 183, 465.
Formosa, 27.
Hamburg, 461.
Hanover, 132, 309, 588.
Havana, 81.
Heilbronn, 387.
Hong Kong, 488.
Japan, 490.
Johannesburg, 133.
Kimberley, 108.
Konigsberg, 613.
Launceston (Tasmania), 4.
Lawrence (New Zealand), 257.
Madrid, 108.
Magdeberg, 387.
Malmö, 42.
Manila, 159.
Maritzberg, 412.
Massachusetts, 614.
Melbourne, 257.
Mexico, 613.
Montreal, 309.
Moss Vale (New South Wales), 613.
New York, 232.
Oyonnax, 338.
Paris, 99, 107, 133, 232, 274, 326, 378, 532, 543, 581, 629.
Pelesh (Roumania), 130.
Pont-de-Vaux, 338.
Port Melbourne (Victoria), 514.
Prague, 640.
Praham (Victoria), 2.
Regensburg, 639.
Richmond (Victoria), 514.
Rome, 27.
St. Moritzbad, 464.
St. Petersburg, 133.
Salonica, 81, 232.
Samarcand, 639.
Sao Paulo (Brazil), 413.
Salzburg, 337.
Selby, 465.
Stockholm, 42.
Strasburg, 438, 540.
Suez Canal, 82.
Sundsvaal, 378.
Sydney, 301.
Temesvar, 2, 174.
Tivoli, 81.
Toronto, 589.
Vaucluse, 532.
Vegesack, 613.
Venice, 438.
Vera Cruz, 282.
Verona, 541.
Vienna, 480, 489.
Warsaw, 183.
Würzburg, 639.

Electric Light and Gas Statistics, 402.
Electric Light Associations, Establishment of, in America, 352.
Electric Light, Deep-Sea Fishing by Means of the, 235.
Electric Light Leads, Lightning in, 654.
Electric Light in Theatres, 3.
Electric Light Regulations, Board of Trade, Draft, 275.
Electric Lighting Acts, *26*, *361*, *648*.
Electric Lighting in London, Present Aspect of: by E. C. de Segundo, 284.
Electric Lighting Provisional Orders, 27, 54, 114, 215, 216.
Electric Lighting, Safety of, 272.

Electric Motors—
Agir, 56.
Alternate Current, at Alzano, Italy, 639.
Baxter, *105*, 125.
C. and C., Ventilating, 55.
Ganz Alternate-Current, *457*.
Henry Gearing for, 590.
New Century, 188.
New Uses for, 2, 402.
Parsons and Co.'s, 405.
Single *v.* Double Motors for Cars, 555.
Sprague, 58, 245.
Sprague Patents in Europe, 183.
Swinburne Alternate-Current, *530*.
Tesla Alternating, New, 617.
Tesla Motor in Mines, *281*, 299.
Thomson-Houston, 433.
Van Depoele Alternate-Current Induction, 63.
Zipernowsky-Déri-Bláthy Synchronous, 452.

Electric Motor Business in America, 377, 555.
Electric Motors in General Railway Work: by Dr. Louis Bell, 575, 600.
Electric Motors, Working Telegraph Instruments with, 354.
Electric Pumps, 631.
Electric Soldering, 590.
Electric Splashes: by Prof. Silvanus P. Thompson, 321 (*see also* 328).
Electric Street Railways *v.* Cable Street Railways, 325.
Electric Tanning, *26*, 126, 639.

Electric Traction, &c.—
Alzano (Italy), 639.
Barmen and Elberfeld Electric Tramway, 256.
Birmingham, Electric Traction at, 55.
Blackpool Electric Tramway, *107*.
Board of Trade, List of Intended Applications to the, for Provisional Orders, 120.
Boston, U.S.A., Electric Traction at, 99, 353.
Bremen, Electric Traction at, 133.
Brighton, The Electric Railway at, 309.
Brisbane, Electric Traction at, 55.
Brussels, Electric Traction at, 232, 515.
Central London Electric Railway, 55, 124, 183, 232, 338, 364, 388, 412, 439, 465, 627, 651.
Chevrant Paper Mills, Transmission Plant at the, 210.
City and Southwark Subway, 183, 458, 488, 506, 515.
Clermont-Ferrand Tramway, 233.
Cost of Electric Traction, *361*, 379, 457, 480, 506.
Data, Electric Traction, Demand for, 403.
Dewey Car Device, *386*.
Development of Electric Traction, *573*.
Development of Electric Traction: by S. Dera Greene, 226.
Distribution of Power by Constant Circuit: by Elmer A. Sperry, 431.
Doncaster (Victoria), Electric Traction at, 81.
Dublin, Electric Traction at, 82.
East London Electric Railway, 431.
Economic Ratio of an Electric Traction System, 274, 303.
Electric Railroad Development in America, 403.
Electric Railroads under Snow, 226.
Electric Street Railways *v.* Cable Street Railways, 325.
Electrical Energy, Distribution of, over extended Areas in Mines: by Albion T. Snell, 294.
England, Electric Traction in, *564*.
Experiment, Electric Traction, 465.
Germany, Electric Traction in, 309, 541, 564.
"Gymnote," The, 183.
Hanover Tramway, Electric Traction on the, 283.
Holland, Electric Traction in, 362.
Inclined Plane Electric Railway at Cincinnati, 311.
Italy, Electric Traction in, 159.
Launches, Electric, 459, 515, 566.
Lea Bridge, Leyton, and Walthamstow Tramway Company, Challenge of the, *255*.
Leeds, The Tramways at, 183.
Liverpool, Electric Traction at, 337, 541.
Liverpool Overhead Railway, 387.
London Tramways Company and Electric Traction, 283, 337.
Mexico, Electric Railway in, 639.
North Metropolitan Tramways, Electric Traction on the, 31, 81, 310, 457, 510.
North-Western and Midland District Auxiliary Railway, Electric Traction on the, 283.
Opposition of the Telephone Companies in America to Electric Traction, 299.
Paris, Electric Traction at, 326, 541.
Plymouth, Electric Traction at, 55.
Practical Points in Electric Car Service: by O. T. Crosby, 213 (*see also 238*).
Reckenzaun, A., on Electric Traction, *637*.
St. Petersburg and Archangel, Proposed Electric Railway between, 363.
St. Petersburg, Electric Traction at, 133.
Scandinavia, Electric Traction in, 42.
Short Railway System, 40, 603.
Spain, Electric Traction in, 2, 54.
Street Railway Current Curve, 625.
Street Railways, Electricity as applied to: by Frank J. Sprague, 442.
Street Railways, Standardisation of Potentials on, 478.
Subdivided Conductors for Electric Traction, 567.
Thomson-Houston Railway System, 28.
Three-Wire System, Electrical Distribution of Energy by the, 429.

Digitized by Google

Electric Traction (*continued*)—
United Kingdom, List of Electric Railways and Tramways in the, 221.
Vienna, Electric Traction in, 387.
Water Gates, Distant Operation of, by Electricity, 542.
Wheless Railway System, 96.
Wynne System of Electric Traction, *411*, 427, 455, 456, 481, 639.
Zipernowsky One-Rail System of Electric Traction, 480.
Electric Welding, *231*, 531, 540, 587, 655: by C. E. Harthan, 190; by Sir Frederick Bramwell, 624.
Electric Welding of Iron Pipes, 183
Electric Welding, Coffin System of, 377.
Electric Welding of Wire Cables, 542.
Electric Welding, Manufacture of Shells by, 639.
Electrical Apparatus, Exports of, 28, 134, 566.
Electrical Energy, Distribution of, over Extended Areas in Mines: by Albion T. Snell, 294.
Electrical Engineering Courses, 515.
Electrical Engineering in America: by G. L. Addenbrooke, 120, 148, 164.
Electrical Engineers, Institution of, 10, 12, 20, 43, 75, 100, 148.
Electrical Engineering, The Study of, 41.
Electrical Insurance, 377, 380.
Electrical Oscillation, *307*, 589.
Electrical Oscillation Detector: by Prof. James Blyth, 442.
Electrical Phenomena in Nature, 363.
Electrical Resonance, Simple Demonstration of, *412*.
Electrical Standardising, Testing, and Training Institution, 209.
Electrical Trades' Section, The, *611*.
Electrical Units, *64*.
Electricity and Light, The Identity of: by H. Hertz, 32.
Electricity and the Law: by A. C. Curtis-Hayward, 366.
Electricity and Veterinary Surgery, 133.
Electricity, Dangers of, 184.
Electricity in relation to the Human Body, Dr. Allen Starr on, 19.
Electricity, Lectures on, 184.
Electricity, More Light on, 582.
Electricity in Warfare: by Lieut. Bradley A. Fiske, 440.
ELSTER, T., and GEITEL, H.
Leakage of Negative Electricity caused by Sun and Daylight, 167.
Electrification, Discharge of, by Flames: by A. M. Worthington, 238.
Electrification due to the Contact of Gases with Liquids: by J. Enright, 73.
Electrification of a Steam Jet: by Shelford Bidwell, 149, 227; by Dr. Oliver J. Lodge, 174.
Electrolysis of Aluminium and Sodium, 74, 338, 515.
Electrolysis of Cryolite: by W. Hampe, 234.
Electrolysis of Distilled Water, 29.
Electrolysis, Production of White Lead by, 403.
Electrolysis, the Theory of, Lectures on, 283.
Electrolytic Preparation of Zinc or Tin, 209.
Electro-Magnet, Rival Claims to the Invention of, *386*.
Electro-Magnet, Prof. Silvanus Thompson's Cantor Lectures on, *361*.
Electro-Magnetic Appliance for Turning on Gas Light, 328.
Electro-Magnetic Radiation, *361*: by Prof. G. F. Fitzgerald, 519; by Dr. Rubens, 543.
Electromotor Meter Patent, Edison's, *487*.
Electro-Therapeutics, 362.
Electrostatic Phenomena presented by Ceresin, 373.
Elektrotechnische Zeitschrift and the *Centralblatt für Elektrotechnik*, Amalgamation of the, 209.
Engine, Newall High-Speed, 196.
Engineering Workshops, Electricity in, 640.
Engines, Electric Light: Robey, 227; Charlesworth, Hall, and Co.'s, 320.
Engineers,' Electricians,' Builders' and Ironmongers' Exhibition, 133, 508, 531.
English Towns, The Electric Light in, 172, 199, 227.
E. P. Combination Fitting, 509.
ENRIGHT, J.
Electrification due to the Contact of Gases with Liquids, 73.
ERSKINE, E. J.
Progress of the Electric Light in Australia, 592.
ESSON, W. B.
Some Points in Dynamo and Motor Design, 423, 450, 474, 494.
Ether Theory of 1889, 432.
Events, Electrical, Summary of, for 1889, 222.
Evershed Ohmmeter, 141.
EWING, Prof. J. A.
Magnetism in Iron and other Metals, 161, 211, 259, 312, 340, 390, 415, 441, 467, 491, 518, 544, 567, 591, 615, 642.
Execution, Electrical, 273, 430, 534, 603, *613*, 629, 639.

Exhibitions.
Birmingham, 2, 88, 412.
Bremen, 133.
Edinburgh, 3, *25*, 27, 33, 79, 83, 96, 108, 133, 198, 221, 245, 284, 309, 362, 388, 465, 542, 564, 566, 589, *628*, *656*.
Engineers', Electricians', &c., 133, 508, 531
Frankfort, 81, 109, 232, 489, 543.
French, in London, 589.
International, at Paris, 452.
Jamaica, 184
Liege, 336.
Machinery, Appliances and Inventions, 483.
Melbourne, 38, 67, 91.
Mining and Metallurgy, 388, 405.
Prague, 640.

Experiment, Electric Traction, 465.
Exports of Electrical Apparatus, 28, 134.
Exports of Telegraph Wires, &c., 565.
Factories, The Electric Light in, 465.
Fairburn and Rawson's Patent Sight-Feed Lubricator, 137.
Faraday Electric Works, 184.
Fawcett Gas Engine, 556.
Feeder Patent, 505, 507.
Feed-Water Heater, Compactum, 459.
Ferranti System in France, The, *183*, 640.
Festivities, 81, 109, 184, 438, 565.
Field Telegraph Work, 183.
Fire at an Edison Station in New York, 232, 273, 338, 386.
Fire at Boston, The, *105*, *181*, 198, 226.
Fire caused by Defective Wires at Glasgow, 490.
Fire in the City, 184.
Fire Risks due to Defective Insulation, *638*.
Fishing, Deep-Sea, by means of the Electric Light, 235.
FISKE, Lieut. BRADLEY A.
Electricity in Warfare, 440.
Fiske Range and Position Finder, 235.
Fittings, Artistic Electric Light, 628.
FITZGERALD Prof. G. F.
Electro-Magnetic Radiation, 519.
Five-Wire System, Siemens, 3.
Fixing Magnetic Curves, 488, 533.
Flames, Behaviour of, in the Neighbourhood of Influence Machines, 174, 200, 227.
Flames, Coloured, Conductivity of, 364.
Flames, Discharge of Electrification by; by A. M. Worthington, 238.
FLEMING, Prof. J. A.
Problems in the Physics of an Electric Lamp, 393, 413, 417.
Flood-Page's, Major, Proposals at the Institution of Electrical Engineers, *157*.
Fog Signals, Special, for Cable Ships, 133.
Football, 465.
Forth Bridge, Telegraph Wires across the, 336.
Frankfort, Electrical Exhibition at, 81, 109, 232, 489, 543.
French Colonies, Telegraphic Communication with the, 209.
French Exhibition in London, 589.
French Telegraphs, Reorganisation of the, 3.
Frosting Incandescent Lamp Bulbs, 364.
Fuse, Scott Instantaneous, 201.
Galvanometers: by Prof. W. E. Ayrton, T. Mather, and Dr. W. E. Sumpner, 348, 370, 388 (*see also 345*, 401, 455, 508).
Ganz Alternate-Current Motor, *437*.
Ganz Transformer, 439.
Gas and Electric Light Statistics, 402.
Gas Companies and the Electric Light, 42, 107.
Gas in Electric Light Conduits, *208*.
Gas, Electro-Magnetic Appliance for Turning on, 328.
Gas Engine, Fawcett, 556.
Gas Governor, Electric, 233.
Gas Lamps, Lighting of, by Electricity, 639.
Gas Leakages and Telegraphic Wire Boxes, 363.
Gases, Passage of Electricity through: by Arthur Schuster, 239, *513*.
Gaulard-Gibbs Transformer Patents in Austria-Hungary, 363.
GEITEL, H., and ELSTER, T.
Leakage of Negative Electricity caused by Sun and Daylight, 167.
Gelatinous Electrolyte for Accumulators, 613.
General Medical Council and Mr. Leeson, *105*, *159*, *183*.
Gerard's Arc Light Formula, *336*.
Gilbert of Colchester, *90*.
Germany, Electric Traction in, 309, 541, 564.
Gilbert Club, *54*, 124.
Glass Insulators, Blue, 167.
Glass and Mica as Insulators, 4.
Glasgow, Fire caused by Defective Wires at, 490.
Glasgow, Overhead Wires in, 133.
Glazebrook, Mr. R. T., Award of the Hopkins Prize to, 109
Globular Lightning at Pontevedra, 414.
Glow Lamps, Life and Efficiency of, 432, 456.
Goitre, Treatment of, by Electricity, 540.
Gooch, the late Sir Daniel, Will of, 103.
Goolden-Evershed Ohmmeter and Mechanical Generator, 141.
GORE, Dr. G.
Rate of Decomposition of Chlorine Water by Light, 114.
Molecular and Associated Changes occurring in Iron and Steel when Heated and Cooled, 345.
Government, The, and the Telephone, *498*.
Graphel, Submarine Cable, Benest, 638, 649.
GRAY, Prof. ANDREW.
Severe Case of Damage by Lightning, 316.
GREENE, S. DANA.
Development of Electric Traction, 226.
GREGORY, W. G.
New Electric Radiation Meter, A, 16.
Method of Driving Tuning Forks Electrically, 17.
Guericke's, Otto von, Air Pump, 233.
Gülcher Thermo Battery, 516.
Gutta-Percha, Artificial, 630.
Gutta-Percha-covered Wires in Cement Conduits, 555.
"Gymnote," The, 183.
Halifax-Bermudas Cable, The, 3, 282, 337, 590.
HAMPE, W.
Electrolysis of Cryolite, 234.
Hanover Tramway, Electric Traction on the, 283.
HANSEN, CARL V.
The Telegraph in Denmark, 420.
HARRIES, ARTHUR, M.D., and LAWRENCE H. NEWMAN.
Alternating *v.* Continuous Currents in relation to the Human Body, 551.
HARTHAN, C. E.
Electric Welding, 190.
HASSON, W. F. C., and DUNCAN, Dr. LOUIS.
Some Tests on the Efficiency of Alternating-Current Apparatus, 523.
HAWES, F. B.
Carbon Deposit in a Blake Telephone Transmitter, 428.
HAYWARD, A. C. CURTIS.
Electricity and the Law, 366.
Heating of Conductors by Electric Currents, *131*, *158*: by A. E. Kennelly, 142, 169, 194; by H. Human, 199.
Henley's (W. T.) Telegraph Works, 152.
Henry Gearing for Electric Car Motors, The, 590.
Henry, The late Prof. Joseph, 630.
Heriot-Watt College, Edinburgh, 362.
Hertz, the Experiments of, Multiple Resonance in Connection with: by E. Sarasin and L. de la Rive, 316.
HERTZ, H.
Identity, The, of Light and Electricity, 32.
Heymann Dynamo Regulator, 505.
HIGGINS, F.
Diathermancy of Air in relation to the Efficiency of Incandescent Lamps, 600.
High and Low Tension, *207*, *396*.
High-Tension Circuits, The New York Board of Health and, 325.
Hine Back Block, 458.
Holland, Electric Traction in, 362.
Holland, Telephonic Communication in, 310.
HOLMAN, G. U. G., and SAFFORD, F. H.
Telephonic Specific Inductive Capacity, 460.
Honours, Paris Exhibition, 4.
Hopkins Prize, Award of the, 109.
Hopkinson, Dr. John, 236.
HOPKINSON, Dr. JOHN.
Magnetism, 245, 269, 290, 320.
House-to-House Electric Light Company's Underground Mains, 367.
Houstholm, Electric Lighthouse, 43, 251.
Human Body, Electricity in relation to the, Dr. Allen Starr on, 19.
Hungary, Industrial Enterprise in, 333.
Hussey Bluestone Battery, 83.
Hydrogen and other Gases, Resistance of, to the Current and to Electrical Discharges, and the Heat Developed in the Spark: by E. Villari, 571.
Imchenetzki Battery, 589.
Imperial Federation League and Cable Rates, *53*.
Incandescent Lamp, A Long-lived, 76.
Incandescent Lamp Bulbs: Frosting, 364; Tinting, 234
Incandescent Lamp Holder, Bernstein, 86.
Incandescent Lamp Signalling, 337.

Incandescent Lamps—
Bristol Portable, 581.
Khotinsky High-Voltage, 283.
Langhans, 542.
Schanschieff Portable, 387.
Incandescent Lamps, Diathermancy of Air in relation to the Efficiency of: by F. Higgins, 600: by C. J. Robertson, 655.
Incandescent Lamps, Form and Efficiency of: by Charles J. Reed, 125.
Incandescent Lamps, Life and Efficiency of, *411*, 432, 456.
Incandescent Lamps, New Vacuum Pumps for, 629.
Incandescent Lamps on Buoys, 185.
Inclined Plane Electric Railway at Cincinnati, 311.
India and China, Telegraphic Communication between, 483.
India, Government Telegraph Code for, 134.
India, Military Telegraphists in, 3.
Indian Telegraph Service, 517, 639.
Indiarubber Asphalte, Mineral, 4.
Indiarubber Market, The, 107, 269, 232.
Indo-European Telegraph Department, 339.
Induction, Telephone, New View of: by John Carby, 122.
Industrial Enterprise in Hungary, 333.
Influence Machines, Behaviour of Flames in the Neighbourhood of, 174, 200, 227.
Influence of Dielectric Media upon Electric Forces, 56.
Inspectional Electric Instruments, Sir William Thomson's, 187.
Inspector, Electrical, for Dublin, 362.
Inspectors, Electrical, 75.
Institute of Patent Agents, 160.
Institution of Civil Engineers, 82, 203, 282.
Institution of Electrical Engineers, 10, 12, 20, 43, 75, 100, 148, *346*.
Insulating Material, A New, 133, 184.
Insulation, The Art of, *335*.
Insulation, Deterioration of, 613.
Insulation in Marine Work, 321.
Insulation, Manila Paper, for Telephone Cables, 542.
Insulations, Wire, A Simple Method of Testing, 28.
Insulator, Flake Mica as an, 74.
Insulators, Blue Glass, 167.
Insulators, Mica and Glass as, 4.
Insulators, Porcelain, The Insulation Resistance of, 55.
Insurance, Dynamo, 239.
Insurance, Electrical, 377, 380.
Interior Wiring, New System of, 151.
International Telegraph Bureau, 412.
International Telegraph Conference, 488, *548*, 565, 613, 641.
Iodine, Action of a Long-Continued Electric Discharge on: by C. Luedeking, 339.
Iron, Electrical Resistance of, Effect of Repeated Heating and Cooling on the: by H. Tomlinson, 97.
Iron-Filing Curves, 488.
Iron, Protection of, from Rust, 643.
Iron, The Deposition of, *512*.
Iron and Nickel, Villari Critical Points of, 547, 582.
Iron and other Metals, Magnetism in: by Prof. J. A. Ewing, 161, 211, 259, 312, 340, 390, 415, 441, 467, 491, 518, 544, 567, 591, 615, 642.
Iron and Steel, The Molecular and Associated Changes occurring in, when Heated and Cooled: by Dr. G. Gore, 345.
Iron Pipe and Man-Hole Underground Main System, 314.
Iron Pipes, Electric Welding of, 183
Italian Government, The, and the Telephones, 107.
Italy, The Alternate-Current Transformer System in, 515.
Jacobus Closed Circuit Burglar Alarm, 364.
Jamaica Exhibition, 184.
Japan, The Telephone in, 209.
Japanese Enterprise, 27, 490.
Joule, Dr., Lecture on the Life of, by E. T. Carter, 108.
Joule, Dr., Proposed Memorial to, 82, 109, *281*, 309.
Joule, Dr., The Scientific Work of, *307*.
Junior Engineering Society, 615, 640.
KAPP, GISBERT.
Report on the Aron Meter, 351.
Keeley System of Working Telegraph Circuits, 162, *538*.
KENNELLY, A. E.
Heating of Conductors by Electric Currents, 142, 169, 194.

Digitized by Google

Kent Arc Lamp, 100.
Kerr's Phenomenon, *464*.
Khotinsky High Voltage Lamps, 283.
Kidderminster, Telephonic Extension at, 283.
King's College, Electrical Engineering at, 641.
Laboratoire Centrale d'Electricité, 480, 581.
Labour Conciliation Committee, *182*.
Lacassagne-Thiers Arc Lamp, 45.
Langhans Incandescent Lamp, 542.
Launch of the Cable Steamer "Relay," 311.
Launches, Electric, 459, 566.
LAW, M. D.
Nine Years with the Arc Lamp, 504.
Law, Electricity and the, 366.
LAWRENCE, H. NEWMAN, and HARRIES, ARTHUR, M.D.
Alternating *v.* Continuous Currents in relation to the Human Body, 551.
Lea Bridge, Leyton and Walthamstow Tramway Company, Challenge of the, *255*.
Leakage of Negative Electricity caused by Sun and Daylight: by T. Elster and H. Geitel, 167.
Lectures, Electrical, 184, 614.
Leeds Association of Foremen Engineers and Draughtsmen, 541.

LEGAL INTELLIGENCE—

Aron Bros. *v.* Watson Bros., 460.
Blackburn *v.* Smith, 100.
Blackburn *v.* the Lancashire and Yorkshire Railway Company, 381.
Brush Electric Company (of Cleveland) *v.* Fort Wayne Electric Light Company, 250.
Brush Electric Company *v.* Julien Electric Company, 554, 588.
Chamberlain and Hookham *v.* Cadogan Electric Light Company, 482.
Chatenay *v.* Brazilian Submarine Telegraph Company, 432.
Christopher *v.* Langworth and others, 460
City and Suburban Telegraph Association *v.* Mount Auburn Street Railway Company, 308.
Fyffe, James, *Re*, 301, 433, 460.
Garman *v.* Brighton and Hove Electric Light Company, 533.
Hinds *v.* Smith, Christopher *v.* Same, 355.
Inland Revenue Department *v.* the Mines and General Telpher Company, 251.
International Cable Company, *Re* the, 301, 355.
Maxim-Weston Electric Company *v.* Watt, 45.
Mr. Monteith *v.* an Electric Lighting Company, 21.
Phillips Bros. *v.* Crompton and Co., 632.
Queen, The, *v.* Redman, 76.
Radcliff *v.* Great Western Railway Company, 482.
South of England Telephone Company, *v.* Brighton Overseers, 251.
Subways in New York, Action *re* the, 532.
United Telephone Company *v.* Mitchell, 45.
United Telephone Company *v.* Smith, 21.
United Telephone Company *v.* Tasker, 175, 301.

Leicester, The Telephone in, 610.
Leipzig Exhibition, 336.
Light and Electricity, The Identity of: by H. Hertz, 32
Light Standard, Violle, 184.
Lighthouse Illuminants Inquiry, 81.
Lighting Power of Arc Lamps, 9.
Lightning, Action of, upon Gas and Water Pipes, 300.
Lightning at Ben Nevis Observatory, 202.
Lightning, Damage by, 465.
Lightning in Electric Light Leads, 654.
Lightning Flash, An Erratic, 566.
Lightning Flash, Optical Feature of the, 358.
Lightning, Globular, at Pontevedra, 414.
Lightning Guard, Lodge, *637*, 644.
Lightning at Limassol, 639.
Lightning at Malta, 3.
Lightning in Mines, 233.
Lightning Protectors, Overhead Telephone Wires as, 134.
Lightning, Severe Case of Damage by: by Prof. Andrew Gray, 516.
Lightning, Ships struck by, 235.
Linemen, Accidents to, in New York, 198.
Litigation, Patent, Storage Battery, 42, 74.
Liverpool Electric Supply Company's New Premises, 438.
Liverpool Overhead Railway, 387.
Liverpool Physical Society, 159.
Liverpool Tramways, Electric Traction on the, 337, 541.
Llanerch Pit, The Explosion at the, 362.
Local Authorities and Overhead Wires, 98, 108.
Local Authorities and the Supply of Electricity, *168*, 413, 439, 465, 487, 489, *596*, 641.
Local Government Board Inquiry at Brighton, 653.
Lockwood, Mr. T. D., on British Telegraphy, *53*.
LODGE, Prof. O. J.
Presidential Address to the Liverpool Physical Society, 579.
Lodge Lightning Guard, *637*, 644.
London Chamber of Commerce, 33, 96, 321, 465, 522, 541, 589, 625.
London County Council and Electric Lighting, 109, 311, 389, 565.
London County Council, Appointment of Engineer of the, 107, 354.
London County Council Testing Station, *106*, 413.
London, Electric Lighting in, Present Aspect of: by E. C. de Segundo, 284.
London Electric Supply Corporation's Underground Mains, 368.
London Subway Railways, Abandonment of Proposed, 283.
London Tramways Company, 283, 337.
Long-Distance Transmission of Electricity in Algeria, 134.
Lubricant, Mustard Oil as a, 108.
Lubricator, Patent Sight-Feed, Fairburn and Rawson's, 127.
Luminous and Non-Luminous Radiation, *563*.
Machinery, Appliances and Inventions Exhibition, 483.
Machinery Notes, 2.
McLaughlin Storage Battery, 388.
Madrid, Electrical Engineering College at, 488.
Magazines, American, Electrical Articles in, 41, *564*.
Magnet Steel, 541.
Magnetic and Electrical Disturbances at the Paris Observatory, 566.
Magnetic Disturbances and Earthquakes, Relation between, 4.
Magnetic Field, The, within a Conductor of Large Section, *448*.
Magnetic Induction and Mechanical Stress, *131*.
Magnetic Permeability of Soft Steel, 411.
Magnetic Properties and Atomic Weights, Relation between, 337.
"Magnetic Resistance," 293, 377.
Magnetic Storms, 387.
Magnetic Survey, The: by Prof. A. W. Rücker, 644.
Magnetism, Advances in, *206*, 293, 327.
Magnetism: by Dr. John Hopkinson, 245, 269, 290, 320 (*see also 231, 307*).
Magnetism in Iron and other Metals: by Prof. J. A. Ewing, 161, 211, 259, 312, 340, 393, 415, 441, 467, 491, 518, 544, 567, 591, 615, 642.
Magnetism, Permanent, A Theory of: by M. Osmond, 645.
Magnetisation, Influence of, on Electrical Conductivity, *540*.
Magneto-Generator and Ohmmeter, Goolden-Evershed, 141.
Magneto-Static Current Meter, 187.
Malta, Lightning at, 3.
Manila Paper Insulation for Telephone Cables, 542.
Manwaren Electric Meter, 212.
Marine Work, Insulation in, 321.
Mariner's Compass, 29, 565.
Maritime Conference at Philadelphia, 3, 133.
Martinique, Telegraphic Communication with, 257.
Mason College Engineering Society, 27.
Massachusetts Electric Lighting Association, 98.
MATHER, T.
Shapes of Movable Coils used in Electrical Measuring Instruments, 577.
MATHER, T., AYRTON, Prof. W. E., and SUMPNER, Dr. W. E.
Galvanometers, 348.
Mather and Platt 30-Unit Alternator, 262.
Mauritius, Cablegrams from, 257.
MAYER, WILLIAM, jun.
Practical Working of the Electrical Subways in New York City, 477, 500.
Measuring Contact Differences of Potential, Simple Method of, 234.
Mechanical Telephone, *132*.
Mehner Dry Cell, 365.
MEIKLE, ANDREW W.
Sir William Thomson's Chain of Electrostatic Voltmeters, 6, 30, 59, 91.
Melbourne Centennial International Exhibition, 1888 and 1889, The Lighting of the: by K. L. Murray, 38, 67, 92.
MELHUISH, W. F.
Signalling Across Rivers in India, 597.
Melting Points, An Electrical Apparatus for Determining, 233.
Memorials, Proposed, 82, 109, 184.
Mercury, Compressed and Uncompressed, Thermo-electric Tension between, 589.
Metals, Various, Alteration in the Conductivity of, after a Lengthened Exposure to a High Temperature, 310.
Meter, Aron: by Gisbert Kapp, 351 (*see also* 379).
Meter, Electric, Competition, 232, 326, 532, 556.
Meter, Electric, Curious Treatment of an, 135, 193.
Meter, Electric, Manwaren, 212.
Meter, Oulton-Edmondson, 111.
Metropolitan Building Act, and the Construction of Central Stations, 322, 352.
Metropolitan Electric Lighting, *207*, 389, 565.
Metropolitan Electric Lighting Companies, Proposed Association of, 283.
Metropolitan Electric Supply Company, Rathbone-place Station of the, 237.
Metropolitan Electric Supply Company's Underground Mains, 368.
Mexico, Electric Railway in, 639.
Mica and Glass as Insulators, 4.
Mica, Flake, as an Insulator, *54*, 74.
Mica, Proposal to Tax, in America, 640.
Michales Electric Mining Machine, 578.
Microphone Interference Case, The, in the United States, *281*.
Military Operations, The Electric Light in, 566.
Mill Lighting, 81.
Mineral Indiarubber Asphaltc, 4.
Mines, Lightning in, 233.
Mines, Use of Electricity in: by M. Chalon, 375.
Mining and Metallurgy, International Exhibition of, 288, 405.
Mining Machine, Michales Electrical, 578.
Mining Motor, Requisites of a, 333.
Mining Operations, Electricity in, 55, 74, 83, 108, 133, 273, 294, 299, 375.
Miot Dynamo, 57.
Molecular Telephone, 629.
Mombassa Cable, 284.
Money Order System, Telegraphic, Extension of the, 387.
Monte Video and Buenos Ayres, Telephone Line between, 135.
Morgan Automatic System of Electric Signalling, 500.
Moscow-St. Petersburg Telephone Line, 256.
Moseley and Sons' Duriflex Packing, 583.
Moseley Pocket Ammeter, 483.
Motors, Wind, for Electrical Purposes, 210.
Municipal Lighting in America, *511*, 430.
Municipal Lighting in South Australia, 107.
MURRAY, K. L.
Lighting of the Centennial International Exhibition, 1888 and 1889, 38, 67, 92.
Mustard Oil as a Lubricant, 108.
Natal, An Addition to the Customs Free List in, 3.
National Electric Light Association Convention at Kansas City, 403, 412, *437*, 454, *475*.
National Electric Light Association on the Overhead Wire Question, 41.
National Fast Telegraphing Tournament, 623.
National Society for the Exemption of Machinery from Rating, 387, 483, 589, 631.
National Telephone Company, Annual Assembly of the, 135.
National Telephone Electrical Society, 97.
Nature, Electrical Phenomena in, 363.
Negative Electricity, Leakage of, caused by Sun and Daylight: by T. Elster and H. Geitel, 167.
New Applications of the Electric Motor, 2, 402.
New Century Electric Motor, 188.

NEW COMPANIES REGISTERED.

The following Companies have been registered under the Limited Liability Acts:—

American Asbestos Company, 103.
Andrews and Preece, 585.
Argentine Inter-Provincial Railway Company, 279.
Bangwaketsi Concessions Syndicate, 333.
Batava, 77.
Birmingham Electric Supply Company, 179.
Camborne Gas Company, 179.
Compania Madilina del Electricidad, 108.
Durand Electric, Petroleum, and Gas Engine and Manufacturing Company, 537.
Ecuador Central Railway Company, 103.
Egestorff (J. A.) and Co., 661.
Electric Meter Company, 537.
Electrical Engineering Company of Ireland, 511.
Electrical Engineering Corporation, 305, 383.
Electrical Standardising, Testing, and Training Institution 253.
Elmore's Wire Manufacturing Company, 537.
Fareham Electric Light Company, 383.
Foreign and Colonial Electrical Power Storage Company, 155, 511.
Fowler, Lancaster, and Company, 279.
Gas Consumers' Protective Association, 179.
Halifax Mutual Electric Light and Power Company, 23.
Heathley, Janisch, and Co., 179.
Kelvinside Electricity Company, 179.
Key's Electric Company, 485.
Lane-Fox Electrical Company, 383.
Lange and Co, 51.
Liverpool Silver and Copper Company, 129.
Maclellan, P. and W., 409.
Macmahon's Patent Electric Check System, 485.
Mill's Cycle Company, 333.
Morgan's Automatic Electric Signal System Syndicate, 333.
Morris Brothers, 157.
Mutual Telephone Company, 383.
New Asbestos Company, 279.
North African Gas Syndicate, 179, 205.
Norwich Electricity Supply Company, 333.
Oriental Association, 103.
Poole and White, 435.
Popp's Patent, Company to Work, 333.
Priestman Oil Engine American Syndicate, 51.
Purnell High Speed Gas Engine and Manufacturing Company, 305.
Syndicate of Electrical Engineers, 253.
Transvaal Oil Engine Company, 51.
Trent Gas Engine Company, 409.
Trust and Loan Company of China, Japan, and the Straits, 179.
Universal Electric Light and Power Trust Corporation, 383.
Venezuela Telephone and Electrical Appliances Company, 661.
Wrexham and District Electric Supply, 205.
Zurich Incandescent Lamp Company, 564.

New South Wales, Technical Education in, 184.
New York State Senate Committee, Report of the, on Electric Lighting, 603.
New York, The Electrical Situation in, 41.
New Zealand Cable, A Second, 389.
Newall High-Speed Engines, 193.
Niagara Falls, Utilising the, 430.
Nickel and Iron, Villari Critical Points of, 547, 582.
Nickel and Tungsten Alloys, Magnetic Properties of, 282.
Night Firing, Electrically Illuminated Sights for, 133.
Night-Signalling at Sea, 3.
Nomenclature, Electrical, *146*, *232*.
North Metropolitan Tramway Company's Lines, Electric Traction on the, 31, 81, 310, 540.
North-Western and Midland District Auxiliary Railway, Electric Traction on the, 183.
North-West Frontier, Telegraphic Extensions on the, 488.
Northern of France Railway, Electric Signalling Apparatus on the, 210.
Norwegian State Telegraphs, 378.

Obituary Notices.

Briscoe, Capt. Alfred P., 488.
Chadburn, Charles Henry, 258.
Cowles, Alfred, 362, 488.
Despointes, Jean François, 253.
Dunn, John George, 573.
Halske, Johann Georg, 526.
Hirn, Gustave Adolphe, 309.
Hoist, L. M., 109.
Lefroy, General Sir John Henry, 589.
Lever, Charles, 215.
Perry, Stephen Joseph, 245.
Snell, William Henry, *437*, 473.
Whitehouse, Edward Orange Wildman, 319.

Oerlikon Works, Extension of the, 257.
Ohm Memorial Fund, 54.
Ohm, Value of the, 363.
Ohmmeter and Magneto-Generator, Goolden-Evershed, 141.
Oil Engine, Priestman, 171.
Okonite Wire, 153.
Old Students' Association, Annual Report of the, 257.
Operative Electricians' Union, 26, 43.
Organs, Church, Electric Power for, 151.

Digitized by Google

OSMOND, M.
Theory of Permanent Magnetism, 645.
Oulton-Edmondson Electricity Meter, *105*, 111.
Overhead Wire Question, *292*; Mr. Edison on, 41; Sir William Thomson on, *386*.
Overhead Wire Rules, 21.
Overhead Wires, Compensators for, 354.
Overhead Wires in America, *1*, 18, 41, 99, 124, 151, 159, *181*, 226, 250, 272, 298.
Overhead Wires, Local Authorities and, 98, 108, 133, 257, 258, 329, 389, 466.
Overhead Wires, Use of Steel Bearers for, 20.
Ozokerite, 302.
Ozone, Preparation of, 55, 126.
Pacinotti, Prof., Reported Death of, *184*.
Paget Alternate-Current Transformer, *106*, 115.
Paper as an Insulating Material, 133.
Paper Factory, Electricity at a, 439.
Paper Mills, Chevrant, Transmission Plant at the, 210.
Paris, Electric Traction in, 541.
Paris Exhibition Honours, 4.
Paris, International Exhibition at, 452.
Paris-Nantes Telephone Line, 107.
Paris Observatory, Electrical and Magnetic Disturbances at the, 566.
Paris Telephone, The, 210.
Parker, Mr. T., Presentation to, 184.
Parliament, Bills in, 284, 310, 414, 440, 466, 490, 515, 639, 651.
Parliamentary Intelligence, 506, 601, 626.
Parsons and Co.'s Dynamos and Motors, 405.
Passage of Electricity through Gases: by Arthur Schuster, 239.
Patent Agents, Institute of, 160.
Patent Laws, American, 99, *588*.
Patent Record, 46, 76, 102, 127, 153, 176, 201, 229, 252, 330, 381, 433, 483, 557, 583, 632, 655.
Patten Alternate-Current Three-Wire System of Distribution, *181*.
Payen Accumulator, 233.
PECK, E. F.
Carbon Tests, 470.
Peculiar Earth, A, 82.
Peculiarities, Some, of Alternate Currents: by Dr. W. E. Sumpner, 60.
Penny Postage Jubilee Dinner, 258.
Persia, The Telegraph in, 337, 489.
Personal Notices, 23, 77, 81, 133, 153, 175, 253, 257, 309, 354, 380, 386, 389, 433, 438, 465, 482.
Pfannkuche Alternator, 347, 533.
Philosophical Society of Glasgow, 488.
Phonograph, The, 534.
Phonopore, The, *107*, 283.
Photo-Engraving, Electricity and, 516.
Photographing Falling Water, 209.
Photographing St. Elmo's Fire, 190.
Photography, Instantaneous, by the Electric Spark, 515.
Pipes, Gas and Water, Action of Lightning upon, 309.
Pipes, Iron, Electric Welding of, 183.
Pittsburg Reduction Company's, The, Method of Producing Aluminium, 74.
Polechko Disc Dynamo, 546.
Pollak Battery, 515, *564*.
Popp System, Efficiency of the, 565.
Porcelain Insulators, The Insulation Resistance of, 55.
Port Said, Telephone Exchange at, 438, 489.
Portable Electric Lamps, 387, 581.
Post Office, The, and the Use of the Telephone, 185.
Postal Telegraph Revenue and Expenditure, 107, 159, 209, 274, 413, 540.
Potassium and Sodium, Amalgams of, Specific Resistance of, 135.
Potential, Contact Differences of, Simple Method of Measuring, 234.
Potentials, Standardising of, on Street Railways, 478.
Practical Points in Electric Car Service: by O. T. Crosby, 213.
Prague, Industrial Exhibition at, 640.
PRESCOTT, G. B.
Methods of Regulating Accumulators in Electric Lighting, 42, 69.
Presentations, 159, 184, 232, 354, 489, 515.
Priestman Oil Engine, 174.
PRITCHARD, O. G.
Electric Arc Light Carbons, 492, 545, 568, 616.
Problems in the Physics of an Electric Lamp: by Prof. J. A. Fleming, 393, 413, 417.
Progress of the Alternating System in America, 250.
Promotion, 389.
Protection of Rubber Trees, 183.
Provisional Orders, Electric Lighting, 27, 54, 117, 159, 215, 216, 439.
Provisional Orders, Electric Traction, 120.
Puluj Telethermometer, 388.
Pump, New Vacuum, for Incandescent Lamps, 620.
Quadruplex Telegraphy, Improvements in, 326.
Quantities of Electricity Induced on "Making" and "Breaking," 488.
Race for Provisional Orders, The, *116*.
Radiation, Comparative, of the Sun and the Electric Arc, *386*.
Radiation Meter, A New Electric: by W. G. Gregory, 16 (*see also 2*).
Railway Companies and the Telephone, 430.
Railway Rates Inquiry, 652.
Railway Signal Devices, Electrical, 82, 134, 210.
Railway Stations, The Electric Light at, 517, 639.
Railway Telegraph Superintendents, Annual Convention of the, 19.
Railways and Tramways, Electric, in the United Kingdom, 221.
Railways, Electric, under Snow, 226.
Range and Position Finder, Fiske, 235.
Rapid Telegraphy, 589, 628.
Rarefied Air, Specific Inductive Capacity of, 543.
Rate of Decomposition of Chlorine Water by Light: by Dr. G. Gore, 114.
Rathbone-place Station of the Metropolitan Electric Supply Company, 237.
RAYLEIGH, Lord.
Clark Standard Cell, 285.
Recalescence and Decalescence, 550
Record Office, Public, The Electric Light at the, 309.
Recording Compass, 234.
Reduction in Telephone Charges, 233.
REED, CHARLES J.
Form and Efficiency of Incandescent Lamps, 125.
Reflecting Instruments, Geometrical Construction of Direct Reading Scales for: by A. P. Trotter, 428.
Regulation of Accumulators, The, in Electric Lighting: by G. B. Prescott, 42, 69.
Regulator, Bernstein, for Constant Current Working, 85.
Reid, Mr. J. D., Farewell Banquet to, 151.
Reignier-Bary Dynamo, 326, *464*, 480.
Re-Invention, An American, 387, 533.
"Relays" Cable Steamer, The New, 311, 466.
Removal Notices, 101, 209, 553.
Repeal of Chilian Import Duties, 3.
Repeal of the Copper Duty, Agitation for the, in America, 352.
Report on the Aron Meter: by Gisbert Kapp, 351, 379.
Report of the Board of Trade on Electric Lighting Bills and Orders of 1890, 466.
Report of the Electric Lighting Committee to the Dublin Corporation, 172.
Report to the St. Pancras Vestry on Electric Lighting: by Prof. H. Robinson, 248.
Report of the Special Committee on the Edinburgh Exhibition, 33.
Report on the Wynne System of Electric Traction, 427, 455.
Reporters, Admission of, to the Meetings of the Institution of Electrical Engineers, *255*.
Reply-Paid Telegrams, 413.
Resistance of Amalgams of Sodium and Potassium, 135.
Resonance, Multiple, in connection with the Experiments of Hertz, *307*, *335*; by E. Sarasin and L. de la Rives, 316.

REVIEWS OF BOOKS, &c.—

Absolute Measurements in Electricity and Magnetism (Andrew Gray), 347.
Aide-Mémoire de l'Ingénieur-Electricien, 550.
Almanach-Annuaire de l'Electricité et de l'Electrochimie, 575.
Alternate-Current Transformer in Theory and Practice, Vol. I. (Dr. J. A. Fleming), 110, 136.
Année Electrique, L' (P. Delahaye), 575.
Annuaire pour l'an 1890, 550.
Calvert's Mechanics' Almanack, 183.
Commercial London, 301.
Dictionary of Electrical Words, Terms, and Phrases, 267.
Electric Light Installations and the Management of Accumulators (Sir David Salomons, Bart.), 549.
Electric Light: its Production and Use (J. W. Urquhart), 499.
Electric Testing of Telegraph Cables (Col. V Hoskiaer), 550.
Electrical Industries, 209.
"The Electrician" Electrical Trades' Directory and Handbook, 550.
Electricity in Modern Life (G. W. de Tunzelmann), 194.
Electrotechnik, Die, in ihrer Anwendung auf des Bauwesen (H. Gorges and K. Zickler), 622.
Examples of Lathes, Apparatus, and Work, 268.
Forth Bridge Special Numbers of *Engineering* and of *Industries*, 439.
Guide to the Correction of Errors in Code (and other) Telegrams, 623.
Indiarubber World and Electrical Trades' Journal, 28.
Instructions for Fixing and Working Dynamo-Electric Machines (W. C. Mountain), 550.
Kalender fur Electrotechniker, 209.
Law Relating to Electric Lighting (G. Spencer Bower and Walter Webb), 293.
Laxton's Price Book for 1890, 550.
Magnetism and Electricity; Advanced and Honours Questions (Andrew Jamieson), 268.
Medical Electricity and Massage (H. Newman Lawrence), 369.
Ordinary and Honours Questions on Electrical Engineering (Andrew Jamieson), 268.
Practical Electrical Notes and Definitions (W. Perren Maycock), 268.
Practical Notes for Electrical Students (A. E. Kennelly and H. D. Wilkinson), 468.
Progrès, Postal, Télégraphique et Téléphonique, Le, 209.
Railway Diary and Officials' Directory, 183.
Traité Théorique et Pratique d'Electrochimie (Donati Tommasi), 621.
Treatise on Statics, A, with Applications to Physics (G. M. Minchin), 574.
Year-Book of Photography for 1890, 301.

Ries Method of obtaining Continuous Currents from Alternating Currents, *106*, 125.
Righi's Researches on the Action of the ultra-Violet Rays, *281*.
RIVE, L. DE LA, and SARASIN, E.
Multiple Resonance in Connection with the Expements of Hertz, 316.
Robbery of Accumulators, 640.
Robey Electric Light Engines, 227.
ROBINSON, Prof. H.
Report to the St. Pancras Vestry on Electric Lighting, 248.
Rope, Endless, Effect of a Thunderstorm upon an, at Kibbleworth Colliery, 365.
Rope Gearing, 473.
Rosebrugh Duplex Telephone System, *281*, 288.
Rowland, Prof., and the Royal Society, 160.
Royal Humane Society's Awards to Electricians, 387.
Royal Meteorological Society, 56, 357, 388.
Rubber Monopoly in Brazil, The, 209, 232, 289.
Rubber Trees, Protection of, 183.
RUCKER, Prof. A. W.
The Magnetic Survey, 644.
Rules, Electrical Installation, in Victoria, 389.
Rules, Standard, for Incandescent Wiring, 209.
Russia, The Telephone in, 354.
Russian Imperial Train, Electric Lighting of the, 184.
RYAN, HARRIS J.
Transformers, 239, 263.
Safety of Electric Lighting, 272.
SAFFORD, F. H., and HOLMAN, G. U. G.
Telephonic Specific Inductive Capacity, 463.
St. Elmo's Fire, *107*, 199.
St. James's and Pall Mall Electric Light Company's Central Station, 287; Switchboard and Regulators, 520; Underground Mains, 268.
St. Mauritius, Electricity in the Mine of, 83.
St. Petersburg and Archangel, Proposed Electric Railway between, 333.
St. Petersburg-Moscow Telephone Line, 256.
St. Thomas, Charterhouse, Schools, 209.
Saline Solutions, Electrical Conductivity of, 4.
Salomon's, Sir David, Scholarship, 437.
Santis Observatory, Electrical Phenomena at the, 315.
SARASIN, E., and RIVE, L. DE LA.
Multiple Resonance in connection with the Experiments of Hertz, 316.
Sautter-Lemonnier Dynamo, 6.
SAYERS, J.
Simple Wiring Equations, 328.
SAYERS, W. B.
Underground Mains of the Hastings Electric Light Company, 186.
Schallenberger Meters, 613.
Schanschieff Portable Electric Lamp, 387.
Schneider Arc Lamp, 471.
School of Science, Telegraphists', 613.
SCHUSTER, ARTHUR.
Passage of Electricity through Gases, 239.
Scotland, The Telephone in, 188, 564.
Scott Instantaneous Fuse, 201.
Screw Thread, British Association, 3.
SEARLE, G. F., and THOMSON, Prof. J. J.
Determination of "*v*," the Ratio of the Electro-Magnetic Unit of Electricity, to the Electro-Static Unit, 619.
Sectional Conductors for Electric Tramways, 455.
Seeing by Electricity, 448.
Seely Electric Light Cable Connector, 517.
SELDEN, CHARLES.
Train Electric Lighting, 15.
Series Electric Traction Syndicate, 283, 386.
Series Electrical Traction Syndicate, Progress of the, 386.
Series Incandescent Lighting, 386.
Shapes of Movable Coils used in Electrical Measuring Instruments: by T. Mather, 577.
Sheffield Telephone Exchange, 108, 541.
Shells, Manufacture of, by Electric Welding, 639.
Ship Lighting, 56, 565.
Ships at Anchor, Telephonic Communication with, 438.
Ships Struck by Lightning, 235.
Short Electric Railway System, 40.
Short Series System in America, 633.
Shot-Hoists, Electric, 209.
Siemens and Halske, Messrs., 387.
Siemens and Halske Transformer, 73.
Siemens, Dr. Werner von, 256, 336.
Siemens Five-Wire System, 3.
Siemens Underground Main System, 315.
Sights, Electrically Illuminated, for Night Firing, 133
Signal Devices, Railway, Electrical, 82, 134.
Signalling Across Rivers in India, *587*: by W. F. Methuish, 597.
Signalling Apparatus, Electric, on the Northern of France Railway, 210.
Signalling, Electric, Morgan Automatic System of, 503
Silvertown Strike, 126, *132*.
Singapore-Borneo Cable, Proposed, 160.
Single Circular Hoop, Co-efficient of Self-Induction of a, 630.
Single Magnet Dynamos, 99.
Single Trolley System, The Cincinnatti Telephone Company and the, 479.
Skidding, Resistance to, *612*, *638*.
Skin, Electric Currents in the, 330.
Skin Resistance of Conductors, *488*, *514*.
Sliding Shoe used in the Short System of Electric Traction, 40.
Smart Performance, A, 160.
SMITH, C. MICHIE.
Notes on Atmospheric Electricity and the Use of Sir William Thomson's Portable Electrometer, 66
Smithfield Club Show, 152.
Smokeless Fuel for Generating Steam, 465.
SNELL, ALBION T.
Comparison, A, between the Continental, American and English Dynamo-Electric Machinery, 5, 57, 138 (*see also* 19).
Continuous Outputs of Two-Pole Dynamos and Motors, 469.
Distribution of Electrical Energy over Extended Areas in Mines, 294.
Snow, Electric Railroads under, 226.
Snow-Sweepers, Electric, 210.
Société Générale des Téléphones, Increase of Business of the, 363.
Society of Engineers, 564.
Sodium and Aluminium, Electrolytic Preparation of, 338.
Sodium and Potassium, Amalgams of, Specific Resistance of, 135.
Soldering, Electric, 590.
Soldering Flux, New, 55.
Solignac Arc Lamp, 330.
Solignac System of Distribution, 431.
South African Telegraphy, 363.
South Australia, Municipal Lighting in, 107.
Spain, Electrical Installation Regulations in, 565.
Specific Inductive Capacity of Rarefied Air, *540*, 543.
Sperry Dynamo, Armature and Field-Magnets of the, 57.
SPERRY, ELMER A.
Distribution of Power by Constant Circuit, 431,
SPRAGUE, FRANK J.
Electricity as Applied to Street Railways, 442.
Sprague Motor, 58.

Digitized by Google

Sprague Street Railway Motor, Test of the New: by Dr. Louis Bell, 247 (*see also* 274).
Steam Jet, Electrification of a, 131: by Shelford Bidwell, 149, 227; by Dr. Oliver J. Lodge, 174.
Steel and Iron, The Molecular and Associated Changes Occurring in, when Heated and Cooled: by Dr. G. Gore, 345.
Steels, Soft, Magnetic Permeability of, 414.
Stepanoff Electric Bleaching Apparatus, 542.
Stocher-Sedlaczek Arc Lamp, 277.
Stockholm-Gothenburg Trunk Line, 126.
Stoletow's Actino-Electric Researches, *181*, 188.
Storage Battery Patent Litigation, 42, 74, *588*.
Storage Battery Plates, Amalgamated, Smith's Method of Making, 185.
Storms, Magnetic, 387.
Street Railways, Electricity as applied to *437*: by Frank J. Sprague, 442.
Study of Electrical Engineering, 41.
Stuhl Electrical Alarm Thermometer, 339.
Sturgeon, William, 274.
Subdivided Conductors for Electric Traction, 507.
Subways, Electrical, Practical Working of the, in New York City: by William Maver, jun., 477, 500.
Subways in New York, 532, 604.
Summary of Electrical Events for 1889, 222.
SUMPNER, Dr. W. E.
Some Peculiarities of Alternate Currents, 60.
SUMPNER, Dr. W. E., AYRTON, Prof. W. E., & MATHER, T. Galvanometers, 348.
Surgical Electric Lamps, 363.
Surinam, New Cable to, 339.
SWINBURNE, JAMES.
Theory of Armature Reactions in Dynamos and Motors, 373, 397.
Swinburne's Alternate-Current Motor, *539*.
Swinburne's Reversing Pole Pieces, *539*.
Switch, Adjustable, 88.
Switch, Automatic, for Use with Accumulators, 89.
Switch, Double-Pole Two-Way, Woodhouse and Rawson, 329.
Switchboard and Regulators of the St. James's and Pall Mall Electric Light Company, 520.
Switchboard, Thomson-Houston Arc Light, 344.
Switches, Double-Break, 354.
Synchronous Motor, 452.
Tait, Presentation to Prof., 159.
Talmage Electric Heater, *487*.
Tanning, Electric, Patents, 126.
Tarifa and Ceuta, Proposed Cable between, 412.
Tatlow Battery, 543.
Technical Attachés, 159.
Technical Education, 75, 81, 184, 482.
Telegram, A Costly, 336.
Telegraphists, Military, in India, 3.

Telegraphy—
Afghanistan, the Telegraph in, 256.
Agitation among the Telegraph Clerks, 543, 641.
Atmospheric Electricity, Curious Effect of, upon an Underground Telegraph Wire, 440.
Australasian Telegraph Statistics, 310.
Baudot Telegraph, 252.
Bavaria, The Telegraph in, 233.
Benest Submarine Cable Grapnel, *638*, 640.
Bermudas-Halifax Cable, 3, 282, 337.
Brazil, The Telegraph in, 489, 613.
Brazilian Government, The, and the Western and Brazilian Telegraph Company, 17, 96, 256.
British Telegraphy, Mr. T. D. Lockwood on, *53*.
Burmah, The Telegraph in, 541.
Cable Interruptions, 107, 282, 309, 590.
Cable Laying, 75, 257, 284, 309.
Cable Rates: Henniker Heaton on, *385*; Sir James Anderson on, *463*; Imperial Federation League and, *53*.
Cable Repairs, 21, 232, 257, 336, 362.
Cablegrams, Despatch of, by Steamers, 257.
Canadian Telegraphs, 56.
Central Telegraph Staff, Meeting of the, 183.
Chili, The Telegraph in, 489.
Colonial Telegraph Statistics, 363
Column Printing Telegraph Patents, 184.
Costly Telegram, A, 336.
Coulon, M., Resignation of, 282.
Delany Telegraph Line Adjuster, 152.
Denmark, The Telegraph in, 420.
Eastern Telegraph Company's Special Line from London to Marseilles, 283.
Electric Motors for Working Telegraph Instruments, 354.
Exports of Telegraph Wires, &c., 565.
Field Telegraph Work, 183.
Forth Bridge, Telegraph Wires Across the, 338.
French Colonies, Telegraphic Communication with the, 202.
French Telegraphs, 3.
Government Telegraph Code for India, 134.
India and China, Telegraphic Communication between, 489.
Indian Telegraph Service, 517, 639.
Indo-European Telegraph Department, 339.
Institution of Electrical Engineers, Telegraph Men and the, *1*, *25*, *79*.
International Telegraph Bureau, 412.
International Telegraph Conference, 488, 565, 613, 641.
Keeley System of Working Telegraph Circuits, 162, *588*.
Lecture on the Telegraph: by Dr. O. J. Lodge, 108.
Martinique, Telegraphic Communication with, 257.
Mauritius, Cablegrams from, 257.
Mombassa Cable, Laying of the, 284.
Money Order System, Telegraphic Extension of the, 387
Moving Trains, Telegraphing to, 183.
National Fast Telegraphing Tournament, *612*, 628.
New Telegraph Wire between Aberdeen and London, 489.
New Zealand Cable, A Second, 389.
North-West Frontier, Telegraph Extensions on the, 488.

Telegraphy (*continued*)—
Norwegian State Telegraphs, 378.
Persia, The Telegraph in, 337, 489.
Postal Telegraph Revenue and Expenditure, 107, 159, 209, 274, 412, 540.
Proposed Cable between Cayenne and the Antilles, 134.
Proposed Cable between Singapore and Borneo, 160.
Proposed Cable between Tarifa and Ceuta, 412.
Proposed New Atlantic Cable to Canada, 309.
Quadruplex Telegraphy, Improvements in, 326.
Rapid Telegraphy, 589, 628.
"Relay," Cable Steamer, The New, 311, 466.
Reply-Paid Telegrams, 413.
School of Science, Telegraphists', 613.
Shetland Cable, Interruption of the, 591.
South African Telegraphy, 363.
Surinam, New Cable to, 339.
Sweden, The Telegraph in, 251.
Telegraph and Electric Light Wires in Canada, 589.
Telegraph, The, and the Telephone, *372*.
Telegraphists, Grievances of, *524*, *564*, *587*, 601.
Thomson, Sir William, and the Founders of Submarine Telegraphy, *255*.
United States Government, The, and the Telegraphs, *411*, 430, 565.
University Boat Race, Telegraphing the Result of the, 515, 543.
Western Union Telegraph Company's New Cables, 75, 309.
Wire Boxes, Telegraphic, and Gas Leakage, 363.

Telephony.
Audio Telephone Mouthpiece, 534.
Austria, Telephonic Development in, 629.
Berlin and Vienna, Telephone Line between, 337.
Buenos Ayres and Monte Video Telephone Line, 135.
Carbon Deposit in a Blake Transmitter: by F. B. Hawes, 428.
Chili, The Telephone in, 489.
Christiania Telephone Company, 126, 373.
Cincinnati Telephone Company and the Single Trolley System, *308*, 479, *487*.
Co-operative, 56, *80*, 201.
Denmark, the Telephone in, 43, 421.
Derbyshire, The Telephone in, 541.
Determination of Dielectric Constants by Means of the Telephone, 83.
Disturbances on Telephone Circuits: by Arthur E. Cottrell, 83.
Domestic Telephones, 370, 404, 432.
Dry Batteries for Telephone Work, 490.
Dumfries and Carlisle, 589.
Duplex Telephony, 287, 326.
Festivities, 81, 109.
France, 378.
Germany, 134, 208, 466.
Government, The, and the Telephones, *498*.
Hampshire, 107.
Holland, Telephonic Communication in, 310.
Induction, Telephone, New View of: by John J. Carby, 122.
Institution of Electrical Engineers, Telephone Men and the, *79*.
Italian Government, The, and the Telephones, 107.
Japan, 202.
Kent, 81.
Kidderminster, 283.
Lectures on the Telephone, 134.
Leicester, 82, 640.
London, 208.
Manila Paper Insulation for Telephone Cables, 542.
Mechanical Telephone, *133*.
Molecular Telephone, 629.
Morgan Automatic System of Electric Signalling, 500.
Norway, 251.
Opposition of the Telephone Companies in America to Electric Traction, 299.
Overhead Telephone Wires as Lightning Protectors, 134.
Paris, 210, 378, 629.
Paris-Nantes Telephone Line, 107.
Port Said, Telephone Exchange at, 438, 489.
Post Office, The, and the Use of the Telephone, 185.
Promotion, 389.
Railway Companies and the Telephone, 430.
Reduction in Telephone Charges, 283.
Rosebrugh Duplex Telephone System, *281*, 288.
Russia, 3, 256, 354.
St. Helens and Birmingham, 336.
St. Petersburg-Moscow Telephone Line, 256.
Scotland, 108, 564, 613.
Sheffield, 108, 541.
Ships at Anchor, Telephonic Communication with, 438.
Silicium-Bronze Wire for Telephones, 126.
Smart Telephone Performance, 82.
Société Générale des Téléphones, 431, 480, 532.
Stockholm Telephone Subscription, *26*.
Sweden, 43, 126, 250, 378, 379.
Telegraph, The, and the Telephone, *372*.
Telephonic Disturbances, New Views on, *106*.
Telephonic Specific Inductive Capacity, *463*; by F. H. Safford and G. U. G. Holman, 469.
Tunis, Telephony in, 337.
Universal Electric Telephone, 583.
Vienna-Budapest Trunk Line, 209, 480.
Vienna-Prague Trunk Line, 125, 480.
West of England, Telephonic Development in the, 466.
Western Union Telegraph Company and the Telephone, 198.
Yorkshire Telephonists, Social Gathering of, 565.

Telethermometer, Puluj, 388.
Telpher Line at Tirupati, 27.
Temperature of the Air at Great Heights, Determination of the, 82.
Tempered Copper for Electrical Work, 414.
Terrestrial Magnetism, Diurnal Variations of, *437*.
Tesla Alternating Motor, New, 617.
Tesla Method of obtaining Continuous Currents from Alternate Currents, *25*, 42.
Tesla Motor in Mines, *281*, 299.
Testing Station, London County Council, 413.
Theory of Accumulators, The, 44.
Thermo-Couples, Calibration of, for High Temperatures, *361*.
Thermometer, Stuhl Electrical Alarm, 339.
THOMPSON, Prof. SILVANUS P.
Review of Dr. J. A. Fleming's "Alternate Current Transformer in Theory and in Practice," 110, 136.
Electric Splashes, 321.
Thomson Electric Welding Process in the Navy, 531.
Thomson-Houston Arc-Light Switchboard, 344.
Thomson-Houston Dynamo, The, 59.
Thomson-Houston Electric Company, Progress of the, 515.
Thomson-Houston System of Electric Traction, 28.
THOMSON, Prof. J. J., and SEARLE, G. F.
Determination of "v," the Ratio of the Electro-Magnetic Unit of Electricity, to the Electro-Static Unit, 619.
THOMSON, Sir WILLIAM.
Resistance of Conductors to Transient Currents, 490, 571.
Thomson, Sir William, and the Founders of Submarine Telegraphy, *255*.
Thomson's, Sir William, Chain of Electrostatic Voltmeters: by Andrew W. Meikle, 6, 30, 59, 91.
Thomson's, Sir William, New Inspectional Electric Instruments, 187.
Thury Six-Pole Dynamo, The, 5.
Tinting Incandescent Lamp Bulbs, 234.
TOMLINSON, HERBERT.
Effect of Repeated Heating and Cooling on the Electrical Resistance of Iron, 97.
Villari Critical Points of Nickel and Iron, 547, 582.
Three-Wire System, Electrical Distribution of Energy by the, 429.
Thunderstorm, Effect of a, upon an Underground Endless Rope at Kibblesworth Colliery, 365.
Thunderstorms, Severe, 234.
Timing Valve fitted to the Otto Gas Engine, 89.
Tin, Electrolytic Preparation of, 200.
Tirupati, Telpher Line at, 27.
Traction, Electric, Development of: by S. Dana Greene, 226.

TRADE NOTES AND NOTICES.—
Acme Electrical Works, 176, 433.
Agricultural Engineers' Association, 354.
Agricultural Hall, 606.
Allpress and Belshaw, 354.
Amalgamated Union of Electrical Operatives, 330.
Appointments Vacant, 127, 175, 606.
Audio Telephone Mouthpiece, 534.
Baird, Thompson and Co., 605.
Bell's Asbestos Company, 251.
Bernstein Electricitätswerke, 510.
Binko (H.) and Co., 301.
Blamire's Patent Indicating Apparatus, 433.
Blenheim and Co., 433.
Bonnella, D. H., 301.
Britannia Company (Colchester), 200, 483.
Business Changes, 23, 433.
Cable for Sale, 228.
Calendars and New Year's Novelties, 200, 330.
"Commercial London," 301.
Consolidated Telephone Construction and Maintenance Company, 153.
Crompton and Co., 300.
Davey, Paxman and Co., 300.
Davis (John) and Son, 127, 153.
Directory, National Telephone Company's Scottish, 354.
Dissolutions of Partnership, 276, 354, 404, 459, 483, 606.
Drake and Gorham, 404, 606.
Edison Electric Light Company (New York), 229.
Electric Apparatus Company, 228.
Electric Construction Corporation, 276.
Electric Launches, 459.
Electric Light Engines, 277.
Electric Light, The, in Sydney, 301.
Electric Light and Power Risks in America, 380.
Electric Lighting in South Wales, 251.
Electric Motors for Working Telegraph Instruments, 354.
Electric Pumps, 631.
Electric Supply Company (Chicago), 101.
Electric Testing Stations, 534
Electric Welding Syndicate, 276.
Electrical Accessories Company, 330.
Electrical Engineering Corporation, 276.
Electrical World of New York, 380.
Endolithic Ivory Company, 251.
Exemption of Machinery from Rating, 483, 631.
Felten and Guilleaume, 300.
Fire Risks, Electric Light, 228.
Fitch Battery and Electric Company (New York), 251.
Fowler, Lancaster and Co., 277.
Ganz and Co., 556.
Gas Journals and the Electric Light, 101.
General Electric Company, 153.
Glass Globes for Electric Lighting, 175.
Goolden (W. T.) and Co., 101.
Great Tower in London, 330, 631.
Gülcher Electric Light and Power Company, 127.
Holmes (J. H.) and Co., 101.
Hulett (D.) and Co., 631.
Humphrys, Tennant and Co., 175.
International Exhibition of Machinery, Appliances, and Inventions, 483.
International Exhibition of Mining and Metallurgy, 405.
Johnson and Phillips, 509.
Laing, Wharton, and Down Construction Syndicate, 101.
London County Council, 354.
Marshall, Sons, and Co., 556.
Mavor and Coulson, 228.
Metropolitan Asylums Board, 631

Digitized by Google

TRADE NOTES AND NOTICES (*continued*)—
Netham Chemical Company, 127, 153.
New Compass Ammeter, 483.
Okonite Wire, 153.
Ozonised Products, 631.
Paddington Lighting, 127.
Parsons (C. A.) and Co., 300.
Paterson and Cooper, 200, 509.
Personal, 153, 175, 354, 380, 433, 482.
Phonograph, The, 534.
Phonograph and the Typewriter, 176.
Pink, Ernest G., 606.
Poole and White, 153, 534.
Planet Engineering Company, 127.
Plant for Sale, 534.
Price, Talbot, and Co., 127.
Removal Notices, 101, 200, 556.
Robey and Co., 380.
Roebling (John A.), Sons, and Co., 200.
Rooker (W. O.) and Tozer, 101.
Sales by Auction, 101, 127, 153, 405, 433, 450, 482, 509, 631.
Schmidt-Douglas Electric Company, 101.
Scientific Appliances Manufacturing Company, 127.
Scott (Ernest) and Co., 127.
Self-Winding and Synchronising Clock Company, 127.
Shippey Brothers, 405.
Société Electricité et Hydraulique, 223.
South of England Telephone Company, 534.
Spanish Telephones, 534.
Stanhope Patent Telephones, 251.
Stanley, Morrison, and Co., 534.
Statter (J. G.) and Co., 153, 330.
Swinburne and Co., 276.
Telegraph Manufacturing Company, Helsby, 228.
Telephone Patents for Sale, 251.
Tenders, Results of, 175, 459.
Tenders Wanted, 101, 153, 200, 251, 276, 300, 354, 433, 482, 556, 606.
Thompson-Houston Electric Motor, 433.
Thompson and Rew, 101.
Tropical American Telephone Company, 127.
Tubes and Fittings, 301.
Tudor Accumulator, 330.
United Asbestos Company, 459, 631
Universal Electric Telephones, 583.
Universal Telephone Company, 510.
Verity (B.) and Sons, 101.
Wenham Company, 583.
Willcox (W. H.) and Co., 556.
Woodhouse and Rawson, United, 300, 380, 606.
Woodley, Robert, 301.
Year Book of Photography for 1890, 301.
Zurcher Telephongesellschaft, 405, 583.

Train Electric Lighting: by Charles Selden, 15.
Train Lighting, 184.
Training for the Electrical Industry, *318*, 353.
Trains, Moving, Telegraphing to, 183
Tramways, Electric (*see* Electric Traction).
Tramways and Railways, Electric, in the United Kingdom, 221.
Transformer Devices, 300.

Transformers—
Constant-Current, 113.
Ganz, 439.
Gaulard-Gibbs Patents in Austria-Hungary, 363.
Paget Alternate-Current, 115.
Siemens and Halske, 73,

Transformers: by Harris J. Ryan, 239, 263.
Transient Currents, Resistance of Conductors to: by Sir William Thomson, 490, 570.
"Transmuter," An Alternate-Current, 274.
Transvaal, Electrical Apparatus for the, 28, 566.
Trial of the Manager of an Electric Light Company, 639.
Trust, Electrical, Rumoured, 603, 629.
Tudor Accumulator Manufactory, Purchase of the, 256.
Tuning-Forks, A Method of Driving, Electrically: by W. G. Gregory, 17.
Tunis, Telephony in, 337.
TROTTER, A. P.
Geometrical Construction of Direct Reading Scales for Reflecting Instruments, 428.
Wire Gauges, 8.
Twisted Strips, Behaviour of, *464*.
Ultra-Violet Rays, Actino-Electric Effect of the, 233.
Underground Conductors: by David Brooks, 87.
Underground Mains: by G. L. Addenbrooke, 260, 285, 313, 342, 367, 391 (*see also* 328, 413, *422*).
Underground Mains of the Hastings Electric Light Company: by W. B. Sayers, 186 (*see also* 227).
Underground Wires in Paris, 314.
Union, Operative Electricians', 43.
United Kingdom, Central Lighting Stations of the, 222, 232, 251.
United Kingdom, Electric Railways and Tramways in the, 221.
United States Government, The, and the Telegraphs, *411*, 430, 565.
University Boat Race, The, 515, 543.
University College, Liverpool, 2.
"r," the Ratio of the Electro-Magnetic Unit of Electricity, A Determination of, to the Electro-static Unit, *612*: by Prof. J. J. Thomson and G. F. Searle, 619.
Vacuum, Conductivity of a, *464*.
Van Depoele Alternate-Current Induction Motor, *53*, 63.
Van Rysselberghe System in Austria, 283.
Variable Currents, Mechanical Action of, *412*.
Ventilating Electrical Conduits, 29.
Ventilating Motors, C. and C. Electric, 55.
Verity Cricket and Football Club, 465.
Veterinary Surgery, Electricity and, 133.
Victoria, Electrical Installation Rules in, 389.
Vienna-Budapest Telephone Trunk Line, 209, 480.
Vienna, Imperial Technological Museum at, 629.
Vienna-Prague Trunk Line, 125, 480.
VILLARI, E.
Resistance of Hydrogen and other Gases to the Current and to Electrical Discharges; and the Heat developed in the Spark, 571.
Villari Critical Points of Nickel and Iron: by H. Tomlinson, 547, 582.
Violle Light Standard, 184.
Voltages, Attempt to Rest ict, 479.
Voltaic Arc, Counter-Electromotive Force of the, 326.
Voltmeter, Cardew, 27.
Voltmeter, Multicellular-Electrostatic, 6.
Voltmeter, Twisted Strip, Ayrton and Perry's: by Prof. J. Perry, 647.
Voltmeter, Vertical Scale, 59.
Voltmeters, Electrostatic, Sir William Thomson's Chain of: by Andrew W. Meikle, 6, 30, 59, 91.
Waite Indicating Dynamometer, 531.
Warfare, Electricity in: by Lieut. Bradley A. Fiske, 440.
Watches, Demagnetising, Apparatus for, 438.
Water, Distilled, Electrolysis of, 29.
Water, Falling, Photographing, 209.
Water Gates, Distant Operation of, by Electricity, 542.
Watt, James, Proposed International Memorial to, 184
Welding by Electricity, *620* (*see also* Electric Welding)
West of England, Telephone Development in the, 466.
Western Union Telegraph Company and the Telephone, 198.
Western Union Telegraph Company and the United States Postmaster-General, 74, 98.
Western Union Telegraph Company's New Cables, 75, 309.
Westinghouse Alternating-Current Apparatus, 551, *587*.
Westinghouse Alternating-Current Arc Lighting System, 273, 551, *611*, 623.
Westinghouse Company, Development of the, 353.
Westinghouse Transformer Tests, *308*, *412*.
Weymersch Battery, 454.
Wheless Electric Railway System, 96.
White Lead, Production of, by Electrolysis, 403.
Wiedemann's Annalen, 439.
Wind Motors, for Electrical Purposes, 210.
Wine Vaults, Electricity in, 516.
Wiring Equations, Simple: by J. Sayers, 328.
Wire Boxes, Telegraphic, and Gas Leakages, 263.
Wire-Covering Machine, Barraclough's, 530.
Wire Gauges, I: by A. P. Trotter, 8.
Wire Insulations, Simple Method of Testing, 20.
Wires, Iron, Nickel and Cobalt, Effect of Tension upon Magnetic Changes of Length, *612*: by Shelford Bidwell, 649.
Wiring, Incandescent, Standard Rules for, 299.
Wiring, Interior, New System of, 151.
Wiring Recommendations of the Boston Electric Light Committee, 273.
WITZ, M. A.
Researches on the Reversal of Polarity of Series Dynamos, 618.
Wolverhampton, New Works of the Electric Construction Corporation at, 28.
Woodhouse and Rawson Double-Pole Two-Way Switch, 329.
Word Coining, *564*, 582, 631.
World's Fair in America, 309, 412.
WORTHINGTON, A. M.
Discharge of Electrification by Flames, 233.
Wynne System of Electric Traction, *411*, 427, 455, 456, 481, 639.
Yorkshire College, The Chair of Engineering at, 81.
Young Circuit Breaker, 378.
Zinc, Electrolytic Preparation of, 209.
Zipernowsky-Déri-Blathy Synchronous Motor, 452.
Zipernowsky System, Progress of the, 133.

Leading Articles and Editorial Notes.

(In this Section LEADING ARTICLES are shown in Capitals.)

ADVANCES IN MAGNETISM, 266.
Alternate c. Continuous Currents in Relation to the Human Body, 539, 563, 611.
Alternate Currents, Mr. Ries' Device for Rectifying, 106.
Alternate Currents, Nikola Tesla's Methods of Rectifying, 25.
American Patent Law, 588.
American Telegraphs, The Proposed Partial Transfer of, to the Government, 411.
Arc, The, Counter E.M.F. of, 303.
Arc Light Formula, M. Gérard's, 336.
Areas, The, Allotted to the Metropolitan Electric Supply Companies, 207.
Armature Reaction in Dynamos and Motors, The Theory of, 385.
Aron Meter, The, Mr. Kapp's Report on, 335.
ART OF INSULATION, THE, 192.
Bath, Electric Lighting at, 540.
Baxter Car-Motor, The, 105.
Benest Submarine Cable Grapnel, 638.
Bernstein System, The, 105.
Bismuth in the Magnetic Field, 362.
Blackpool Tramway, The, 107.
"Blocking Orders," 207, 335.
Board of Trade Regulations, New, 255.
Boston, The Fire in, 105, 181.
Brain Work and Manual Work, 514.
Brighton Municipal Central Station, The, 303.
Brooks' System, The, 79.
Brown's, Mr. A. R., Method of Electrical Distribution, 80.
Brown, Mr. Harold P., and High-Pressure Currents, 2.
Brush Company's Dinner, The, 231.
Cable Rates, Mr. Henniker Heaton on, 385.
Cable Rates, The Reduction of, Sir James Anderson on, 463.
Carhart-Clark Standard Cell, The, 256.
Central London Railway Scheme, The, 80, 611.
Circular Loop of Round Wire, The Co-efficient of, Self-induction of, 611.
City and Guilds Old Students' Association Soirée, The, 182.
CITY GUILDS, THE, AND TECHNICAL EDUCATION, 86.
City, The, Lighting of the, 107, 308.
City and Southwark Subway, The, 638.
Conduction in Gases, Prof. Schuster on, 513.
Conductivity, The Relative, of Metals for Heat and Electricity, 336.
Co-operative Telephony, 80.
Curve Plotting by Photography, 362.
Deaths from Electricity, 157.
Deptford, The Position of Affairs at, 539.
Dewey Car Device, The, 386.
DEVELOPMENT OF ELECTRIC TRACTION, THE, 572.
Dynamo and Motor Design, Mr. W. B. Esson on, 411, 513.
Edinburgh Exhibition, The, 646.
Edinburgh, Proposed Meeting of the Institution of Electrical Engineers at, 25.
Edinburgh Town Council, The, and the Electric Light, 53.
Edison Canadian Patent, The, 157.
Edison Patents, 157, 463, 487.
Edison Primary Battery, The, 158.
Edison and Sprague Companies, The Fusion of, 158.
EIGHTEEN HUNDRED AND EIGHTY-NINE, 220, 242.
Electric Car Service, Practical Points in, 208.
Electric Lighting Acts, A Flaw in the, 26.
Electric Lighting Acts, The, 361.
Electric Lighting Acts Amendment Bill, 638.
Electric Oscillation Experiments by MM. Sarasin and Rive, 307.
Electric Radiation Meter, An, 2.
Electric Resonance, Simple Demonstration of, 412.
Electric Tanning, 24.
Electric Traction, The Cost of, 361.
Electric Traction, Mr. Reckenzaun on, 637.
Electric Traction in England, Mr. Graff Baker on, 564.
Electric Welding, 231, 587.
Electrical Coast Communication, 208.
Electrical Data, The Collection of, 307.
Electrical Execution, 612.
ELECTRICAL NOMENCLATURE, 146.
Electrical Trades' Section, The, 611.
Electrical Trade, The, and the Edinburgh Exhibition, 25, 79.
ELECTRICAL UNITS, 64.
Electro-Magnet, The, Rival Claimants to the Invention of, 386.
Electro-Magnet, The, Prof. Silvanus Thompson's Cantor Lectures on, 361.
Electro-Magnetic Radiation, Prof. Fitzgerald on, 514.
Electromotor Meter Patent, Edison's, 487.
"Feeder" Patent, Edison's, 463.
Ferranti Alternators, The, at the Halles Centrales, 182.
Fire Risks due to Defective Installations, Prof. Andrew Jamieson on, 638.
Flood-Page's, Major, Proposals at the Institution of Electrical Engineers, 157.
Galvanometers, Prof. Ayrton's Paper on, 335.
Ganz Alternate-Current Motor, The, 437.
Gas in Electric Light Conduits, 208.
General Medical Council, The, and Mr. Lecson, 105, 159, 183
Gilbert Club, The, 54.
GILBERT, OF COLCHESTER, 90.
GOVERNMENT, THE, AND THE TELEPHONE BUSINESS, 498.
Heating of Conductors, The, by Electric Currents, 131, 158.
HIGH AND LOW TENSION, 396.
High and Low Tension Rivalry, 207.
Hopkinson's, Dr., Presidential Address, 231, 307.
Imperial Federation League and Cable Rates, The, 53
Incandescent Lamps, The Life and Efficiency of, 411.
INSTITUTION OF ELECTRICAL ENGINEERS, 10, 346.
INTERNATIONAL TELEGRAPH CONFERENCE, THE, 543.
Iron, The Deposition of, 232.
Iron-Filing Curves, 488.
Joule, Dr., International Memorial to, 231.
Joule, The Scientific Work of, 307.
Keeley System of Working Long Submarine Cables, 588.
Kerr's Phenomenon, 464.
Labour Conciliation Committee, The, 182.
Lea Bridge, Leyton, and Walthamstow Tramway Company, The, Challenge of, 255.
LOCAL AUTHORITIES AND THE ELECTRIC LIGHT, 168.
LOCAL AUTHORITIES AND ELECTRIC LIGHTING ORDERS 596.
Lockwood, Mr. T. D., on British Telegraphy, 53.
Lodge's, Dr., Lightning Protector, 637.

Digitized by Google

Leading Articles and Editorial Notes (*continued*).

Luminous and Non-luminous Radiation, 563.
Magazines, The, Electrical Articles in, 561.
Magnetic Changes of Length, Effect of Tension upon, 612.
Magnetic Field, The, within a Conductor of Large Section, 438.
Magnetic Induction and Mechanical Stress, 131.
Magnetic Survey, The, 638.
Magnetization, Influence of, on Electrical Conductivity, 540.
Mechanical Telephone, The, 132.
Metropolitan Electric Supply Company, The, 157.
Mica as an Insulator for Electrical Conduits, 54.
Microphone Interference Case, The, in the United States, 281.
Multiple Resonance in Connection with Electric Oscillations, 307, 335.
Municipal Authorities and Electric Lighting Orders, 487.
Municipal Lighting in the States, 411.
Municipal Testing Laboratory, A, for London, 106.
NATIONAL ELECTRIC LIGHT ASSOCIATION, THE, 472 (*see also* 565).
National Electric Light Association, The, Meeting of, 437.
Nickel and Tungsten Alloys, The Magnetic Properties of, 282.
Nomenclature, Electrical, 232.
Operative Electricians' Union, The, 26.
Oulton-Edmondson Meter, The, 105.
Overhead Wire Accident in New York, 1.
Overhead Wire, Cutting the, in New York, 181.
Overhead Wire Question, The, Sir William Thomson on, 396.
OVERHEAD WIRES AND THE ELECTRIC LIGHT, 292.
Pacinotti, Prof., Reported Death of, 183.
Paget Transformer, The, 106.
Paris Municipality, The, and Foreign Electrical Plant, 587.
Patten Alternate-Current Three-Wire System of Distribution, The, 181.
Phonopore, The, in Spain, 107.
Pollak Accumulator, The, 563.
Quantities of Electricity Induced on "Making" and "Breaking," The, 483.
RACE FOR PROVISIONAL ORDERS, THE, 116.
Radiation, Comparative, of the Sun and the Electric Arc, 336.
Reignier-Bary Dynamo, The, 464.
Reporters, Admission of, at the Meetings of the Institution of Electrical Engineers, 255.
Resistance to Skidding, 612, 638.
Righi's Researches on the Action of the Ultra-Violet Rays, 281.
Rosebrugh Duplex Telephone System, The, 281.
St. Elmo's Fire, 107.
St. Pancras, Electric Lighting of, 231.
Salomon's, Sir David, Scholarship, 437.
Sarasin and Rive, Experiments of, on Electric Oscillations, 307.
SEEING BY ELECTRICITY, 448.
Signalling across Rivers in India, 587.
Silvertown Strike, The, 132.
Skin Resistance of Conductors, The, 488, 514.
Snell, Mr. W. H., The Death of, 437.
Specific Inductive Capacity of Air, The, in Various States of Rarefaction, 540.
Steam Jet Experiments, Mr. Shelford Bidwell's, 131.
Stockholm Telephone Subscription, The, 26.
Stoletow's Actino-Electric Researches, 181.
Storage Battery Patent Litigation in the States, 588.
Street Railways, Mr. Sprague on, 437.
Swinburne's Alternate-Current Motor, 539.
Swinburne's Reversing Pole-Pieces, 539.
Talmage Electric Heater, The, 487.
TELEGRAPH AND TELEPHONE, 372.
TELEGRAPH CLERKS' GRIEVANCES, 524
Telegraph Men and the Institution of Electrical Engineers, 1, 25, 79.
Telegraph Operators in America, Discontent among, 564.
Telegraph Tournament, An American, 612.
Telegraphists' Grievances, The, 587.
Telephone Companies, The, and the Single Trolley System, 308, 487.
Telephone Men and the Institution of Electrical Engineers, 79.
Telephonic Disturbances, New Views on, 105.
Telephonic Specific Inductive Capacity, 463.
Terrestrial Magnetism, The Diurnal Variations of, 437.
Tesla Motors for Mining Machines, 281.
Thermo-Couples, Calibration of, for High Temperatures, 361.
Thomson, Sir William, and the Founders of Submarine Telegraphy, 255.
TRAINING FOR THE ELECTRICAL INDUSTRY, 318.
Twisted Strips, The Behaviour of, 464.
UNDERGROUND SYSTEMS OF DISTRIBUTING ELECTRICITY, 422.
"v," A Determination of, 612.
Vacuum, The Conductivity of a, 464.
Van Depoele Alternate-Current Motor, The, 53.
Variable Currents, The Mechanical Action of, 412.
Westinghouse Arc Light System, The, 611.
Westinghouse Alternate-Current Apparatus, Tests of, 587.
Westinghouse Transformer Tests, 308, 412.
WELDING BY ELECTRICITY, 620.
Wire Gauges, 1.
Word-Coining, 564.
Wynne System of Electric Traction, The, 411.

Foreign Correspondence.

AMERICAN NOTES.

Accidents to Linemen in New York, 198.
Alternating-Current Apparatus, 554.
Alternating System, Progress of the, 250.
American Bell Telephone Company, The Government Suit against the, 41, 250.
American Street Railway Association, Meeting of, at Minneapolis, 18.
Arc System, An Alternating, 554.
Baxter Motor, New, 125.
Board of Health and High-Tension Circuits, 325.
Boston Contract for Public Lighting, 325.
Boston Electric Light Company, Wiring Recommendations of the, 273.
Boston Fire, The, 198.
Chicago Auditorium, 378.
China, Electricity in, 99.
Church Organs, Electric Power for, 151.
Cincinnati Telephone Company, The, and the Single Trolley System, 479.
Continuous Currents from Alternating Currents, 42, 125.
Copper Duty, Agitation for the Repeal of the, 252.
Delany Telegraph Line Adjuster, 152.
Destruction of Edison Station in Pearl-street, 273.
Deptford Station, American Opinions on the, 352.
Distribution of Power by Constant Circuit, 431.
Double Carbon Lamp Patent, The, 250.
Duplex Telephony, 326.
East Reading Electric Railway, 431.
Edison Alternate Current Patents, 629.
Edison System, The, A Challenge, 250.
Electric r. Cable Street Railways, 325.
Electric Light Associations, the Establishment of, 352.
Electric Lighting, The Safety of, 272.
Electric Railroads under Snow, 226.
Electric Railroads, Development of, 423.
Electric Motor Business, 377.
Electric Motor, New Applications of the, 402.
Electric Traction, 99, 353, 603.
Electric Traction Data, The Demand for, 403.
Electric Traction, Development of, Mr. Dana Greene on the, 226.
Electric Welding, 377, 531.
Electrical Articles in the Magazines, 41.
Electrical Engineering, The Study of, 41.
Electrical Execution, 273, 430, 603, 629.
Electrical Subways of New York City, The Practical Working of, 500.
Electrical Trust, An, 601, 629.
Heating Effect of the Electric Current on Conductors, 151.
Human Body, Electricity in Relation to the, 19.
Incandescent Lamps, Form and Efficiency of, 125.
Insurance, Dynamo, 299.
Insurance, Electrical, 377.
Interior Wiring, A New System of, 151.
Incandescent Wiring, Standard Rules for, 299.
Massachusetts Electric Lighting Association, The, 98.
Mica, Flake, as an Insulator for Electrical Conduits, 74.
Mines, Electricity in, 273.
Mining and Electricity, 74.
Molecular Telephone, 629.
Motors, 555.
Municipal Lighting, 430.
National Electric Light Association, Convention of the, at Kansas City, 403, 454.
National Fast Telegraphing Tournament, 628.
New York States Senate's Committee's Report on Electric Lighting, 603.
New Western Union Cables, 75.
Niagara Falls, Utilising the, 430.
Overhead Wires, Mr. Edison and, 41.
Overhead Wires and Senators, 99.
Overhead Wires Agitation, 18, 124, 151.
Overhead Wires Cutting in New York, 226, 250, 272, 298.
Overhead Wires, National Electric Light Association on the, 41.
Overhead Wires Question in Boston, 226.
Patent Laws, The, 99.
Pittsburgh Reduction Company's Method of Production of Aluminium, 74.
Postmaster-General, The, and the Western Union Company, 74, 98.
Proposed New Board of Electrical Control, 325.
Quadruplex Telegraphy, Improvements in, 326.
Railway Telegraph Superintendents, Annual Convention of the, at Washington, 19.
Reid, J. D., Farewell Banquets to, 151.
Ries' Method of Securing Continuous from Alternating Currents, The, 125.
Short Series System at Rochester (N.Y.), 603.
Situation, Electric, The, in New York, 41.
Station, New Edison, at Brooklyn, 227.
Statistics of Gas and Electric Light of Massachusetts, 402.
Storage Battery, A Novel, 531
Storage Battery Patent Litigation, 42, 74, 554.
Subway Question in New York, 532, 604.
Telephone, The, and the Western Union Company, 198.
Telephone Companies, Opposition of, to Electric Traction, 299.
Tesla Motor, The, for Mining Purposes, 299.
Thomson Electric Welding Process in the Navy, 531.
United States Government and the Telegraphs, 430.
Vacuum Pump, New, for Incandescent Lamps, 629.
Voltages, Attempts to Restrict, 479.
Waite Indicating Dynamometer, The, 531.
Westinghouse Alternating-Current Arc Lamp, 273.
Westinghouse Company, Development of the, 353.
White Lead, Production of, by Electrolysis, 403.
Young Circuit Breaker, The, 378

PARIS NOTES.

Asile des Aliénés de Vaucluse, The, Installation at, 523
Bercy, Proposed Municipal Station at, 629.
Compagnie Continentale Edison, The, 480.
Edison Exhibition Station, The Purchase of the, 99.
Electric Traction in Paris, 326.
Ferranti Alternators, The, at the Halles Centrales, 274.
Gare de l'Est, The, Installation at, 581.
Grands Boulevards, The, Electric Lighting of, 532.
Laboratoire Centrale d'Electricité, 480.
Laboratoire Centrale d'Electricité, Alternate-Current Measurements at, 581.
Meters Competition, The Paris, 326, 532.
Municipal Station at the Halles, The, 99.
Paris Central Stations, The, Foreign Plant at, 326.
Paris Central Stations, Some Peculiar, 378.
Paris Telephone System, The, Complaints in the Chamber, 378.
Reignier-Bary Dynamo, The, 323, 480.
Société de Physique, the, Exhibition of, 581.
Solignac System of Distribution, The, 431.
Street Lighting in Paris, 378.
Telephone Exchange, The New Paris, 629.
Telephone in the Provinces, The, 378.
Téléphones, The Société Générale des, 431, 480, 532.

SCANDINAVIAN NOTES.

Christiania Telephone Company, The, 126, 378.
Copenhagen, Municipal Central Station at, 379.
Denmark, The Telephone in, 43.
Electric Traction in Scandinavia, 42.
Housthoim Electric Lighthouse, The, 43, 251.
Inland Telegrams, Increase of, in Sweden, 251.
Jönköping, The Telephone at, 378.
Malmö, Large Installation at, 42.
Norwegian State Telegraphs, The, 378.
Stockholm Gas Company, The, and Electric Lighting, 42
Stockholm General Telephone Company, The, 43, 379.
Stockholm-Gothenburg Trunk Wire, The, 126.
Sundsvaal, Municipal Central Station at, 378.
Telephone, The, in Sweden, 250, 379.
Western Norway, Proposed Telephone Company for, 251.

VIENNA NOTES.

Electric Lighting Activity in Austria, 126.
Electrical Department of the Imperial Technological Museum, The, 629.
Municipal Installation at the Vienna Town Hall, The, 480
Silicium Bronze Wire, The Use of, by the Telephone Company of Austria, 126.
Telephoni; Development in Austria during 1889, 629.
Temesvar, Accidents at, 126.
Vienna-Budapest Trunk Wire, The, 480.
Vienna-Prague Trunk Wire, The, 125, 480.
Zipernowsky One-Rail System, The, 480.

Letters to the Editor.

Advances in Magnetism ..... ESSON, W. B., 299.
RAVENSHAW, H. W., 327
CARTER, E. T., 327.

Alternate r. Continuous Currents in Relation to the Human Body ..... FORBES, GEORGE, 555.
LAWRENCE, H. NEWMAN, 581, 610.
SAYERS, HENRY M., 604.
BAILEY, W. O., 604.
BLATHY, OTTO T., 629.

Alternate-Current "Transmitter," An ..... COLE, R. LANGTON, 274.
Badt's Handbook of Incandescent Wiring .... JENKIN, C. FREWIN, 45.
Behaviour of Flames in the Neighbourhood of Influence Machines ..... BOTTOMLEY, J. T., 174.
Carrara Electric Light ..... LANE, DENNY, 432.
City and Guilds Technical Education ..... AYRTON, W. E., 75.
Clark Standard Cell ..... HOFFERT, H. H., 327.
Compound Conductors for Dynamo Armatures LUCKHOFF, G. B., 507.
Continental and English Generating Plant.... WILLANS AND ROBINSON, 19

Digitized by Google

Letters to the Editor (*continued*).

Counter "Electromotive Force" of the Voltaic Arc	SCHUSTER, ARTHUR, 326.
Cost of Electric Traction	HEATHER, H. J. S., 379, 457, 506. RECKENZAUN, A., 481.
Co-efficient of Self-Induction of a Single Circular Loop	BLATHY, OTTO T., 630.
Development of Electric Traction	DAY, GERALD ST. JOHN, 605.
Diathermancy of Air in Relation to the Efficiency of Incandescent Lamps	ROBERTSON, C. J., 655
Disc Winding	SAYERS, W. B., 174.
Double-Break Switches	COCKBURN, ARTHUR C, 354.
Dynamo and Motor Design	PERRY, JOHN, 532. SAYERS, W. B., 555, 604. WRITER OF THE ABSTRACT, THE, 582, 631.
Economic Ratio of a Traction System	HEATHER, H. J. S., 274. BELL, LOUIS, 403.
Electric Light in English Towns, The	C. H. Y., 199, 227.
"Electric Light Installations and the Management of Accumulators"	SALOMONS, DAVID, 582.
Electric Light at Temesvar, The	CLEMENTS, F. W., 174.
Electric Tanning Patents	GROTH, L. A., 126.
Electric Welding	HIGGINS, F., 655.
Electrical Inspectors	YEAMAN, CHAS. H., 75.
Electrifying Steam	LODGE, OLIVER J., 174. BIDWELL, SHELFORD, 227.
Electro-Magnetic Appliance for Turning on Gas Light	NEAVE, JOHN F., 328.
Employment of Chromic Acid instead of Nitric Acid in the Bunsen Cell	PENRUDDOCKE, CHARLES, 21.
Ether Theory of 1839	JOHNSTONE, JAMES, 432.
"Feeder," The Patent	ANDREWS, J. D. F., 507.
Fixing Magnetic Curves	GEE, HALDANE W. W., 533.
Flames and Electricity	JOHNSTONE, JAMES, 200, 227.
Fulham Vestry and the Electric Light	SPOKES, RUSSELL, 404.
Heating of Conductors, The	HUMAN, H., 199.
Henley's (W. T.) Telegraph Works	SUTTON, G., 152.
Hookham Meter Action	SCOTT (MONTAGU J.) AND CO. 199.
House-to-House Station at West Brompton	HALL, CHARLES J., 251.
Institution of Electrical Engineers	TELEGRAPHY, 20, 75. OBSERVER, 43. ELECTRIC LIGHT, 100.
Life and Efficiency of Glow Lamps	ROBERTSON, C. J., 432, 458. SALOMONS, DAVID, 458.
Lightning in Electric Light Leads	LODGE, DR. OLIVER J., 654.
Long-Lived Incandescent Lamp	THOMAS, ORLO' V., 76.
Manufacture of Ozone	LAWSON, JOHN C., 126.
Mapping the Waste Field of Dynamos	TROTTER, ALEXANDER P., 532.
Mr. Kapp's Report on the Aron Meter	A. K. C., 379.
More Light on Electricity	JOHNSTONE, JAMES, 582.
Ocean Cable Repairs	ANDERSON, SIR JAMES, 21.
Operative Electricians' Union	CHAIRMAN OF MEETING on Oct. 23, 1889, 44.
Overhead Wires and the Electric Light	BOZON, R. S., 354.
Overhead Wire Rules	TROTTER, ALEX. P., 21.
Pfannkuche Alternator	PFANNKUCHE, GUSTAVE, 532.
Photographing St. Elmo's Fire	ARNALL, T., 199.
Prof. Ayrton's Paper on Galvanometers	ELLIOTT BROS., 404.
Rival Back Blocks	HINE, J. J., 458.
Sectional Conductors for Electric Tramways	AYRTON, W. E., 455.
Silvertown Strike	TYLER, W. J., 126.
Single and Double Motors for Electric Cars	CROSBY, O. T., 555.
Single-Magnet Dynamos	ESSON, W. B., 99
Subdivided Conductors for Electric Traction	AYRTON, W. E., 507
Street Lighting	MARTINDALE, W., 631.
Telephones for Domestic Use	SWINTON, A. A. CAMPBELL, 404.
Testing Galvanometers	MENZIES, W. J. M., 432. AYRTON, W. E., 455. ELLIOTT BROTHERS, 508.
Theory of Accumulators	SCHOOP, PAUL, 44.
Training for the Electrical Industry	JAMIESON, ANDREW, 353.
Transformer Devices	C. D. S., 300.
Underground Mains	PRACTICAL ELECTRICAL ENGINEER, A, 227. DAY, GERALD ST. JOHN, 328.
Use of Steel Bearers for Overhead Wires	PRACTICAL ELECTRICAL ENGINEER, A, 20.
Use of the Term, "Electric Splashes"	CORRESPONDENT, A., 328.
Villari Critical Points of Nickel and Iron	TOMLINSON, HERBERT, 582
William Sturgeon	THOMPSON, SYLVANUS P, 274.
Word Coining	ROSS, O. C. D., 582. NAVIS, 631.
Wynne System of Electric Traction	WYNNE, FRANK, 456, 481. C. B. B., 482.

Scientific Societies, Papers, &c., read before.

American Academy of Arts and Sciences.

Telephonic Specific Inductive Capacity, 469.	SAFFORD, F. H., and HOLMAN, G. U. C.

American Institute of Electrical Engineers.

Form and Efficiency of Incandescent Lamps, 125.	REED, CHARLES J.
Method of Regulating Accumulators in Electric Lighting, 42, 69.	PRESCOTT, G. B.
Practical Working of the Electrical Subways of New York City, 477, 500.	MAYER, WILLIAM, jun.
Some Tests on the Efficiency of Alternating-Current Apparatus, 593.	DUNCAN, DR. LOUIS, and HASSON, W. F. C.
Transformers, 239, 263.	RYAN, HARRIS J.

Association of Railway Telegraph Superintendents (American).

Train Electric Lighting, 15.	SELDEN, CHARLES.

British Association (Newcastle-upon-Tyne Meeting).

Ayrton and Perry's Twisted Strip Voltmeter, 647.	PERRY, PROF. J.
Discharge of Electrification by Flames, 238.	WORTHINGTON, A. M.
Notes on Atmospheric Electricity and the Use of Sir William Thomson's Portable Electrometer, 66.	SMITH, C. MICHIE.
Passage of Electricity through Gases, 239.	SCHUSTER, ARTHUR.

Chicago Electric Club.

Electric Motors in General Railway Work, 575, 600.	BELL, DR. LOUIS.

City Guilds Old Students' Association.

Some Peculiarities of Alternate Currents, 60.	SUMPNER, DR. W. E.

Congress of German Naturalists.

Identity, The, of Light and Electricity, 32.	HERTZ, H.

Edison Convention.

Heating of Conductors by Electric Currents, 142, 169, 194.	KENNELLY, A. E.

Federated Institution of Mining Engineers of Great Britain.

Distribution of Electrical Energy over Extended Areas in Mines, 294.	SNELL, ALBION T.

Institution of Electrical Engineers.

Meetings, 148, 268.	
Alternating *v.* Continuous Currents in relation to the Human Body, 551. *Discussion*, 553.	LAWRENCE, NEWMAN H., and HARRIES, A.
Diathermancy of Air in Relation to the Efficiency of Incandescent Lamps, 600.	HIGGINS, F.
Electrical Engineering in America, 120, 148, 164. *Discussion*, 166.	ADDENBROOKE, G. L.
Lighting of the Centennial International Exhibition, 1888 and 1889, 38, 67, 92. *Discussion*, 95.	MURRAY, K. L.
Magnetism, 245, 269, 290. *Discussion*, 291, 320.	HOPKINSON, Dr. J.
Signalling Across Rivers in India, 597. *Discussion*, 599.	MELHUISH, W. F.
Some Points in Dynamo and Motor Design, 423, 450, 474, 494. *Discussion*, 526.	ESSON, W. B.
Theory of Armature Reactions in Dynamos and Motors, 373, 397, 530. *Discussion*, 526.	SWINBURNE, JAMES.
Students' Meetings, 27, 82, 133, 363, 413, 465, 515, 639.	

Liverpool Physical Society.

Presidential Address: Inaugural Meeting, 579.	LODGE, Prof. OLIVER J.

Mining and Metallurgical Congress.

Use of Electricity in Mines, 375.	CHALON, M.

National Electric Light Association (Kansas City).

Carbon Tests, 470.	PECK, E. F.
Electricity applied to Street Railways, 442.	SPRAGUE, FRANK J.
Nine Years with the Arc Lamp, 504.	LAW, M. D.
Standardisation of Potentials on Street Railways, 478.	REPORT OF A COMMITTEE.

New York Electric Club.

New View of Telephone Induction, 122.	CARBY, JOHN J.

Philosophical Society of Glasgow.

Electrical Oscillation Detector, 442.	BLYTH, PROF. JAMES.

Physical Society.

Annual Meeting, 370.	
Carbon Deposit in a Blake Telephone Transmitter, 428.	HAWES, F. B.
Effect of Repeated Heating and Cooling on the Electrical Resistance of Iron, 97. *Discussion*, 98.	TOMLINSON, H.
Electric Splashes, 323. *Discussion*, 323.	THOMPSON, PROF. S. P.
Electrification of a Steam Jet, 149. *Discussion*, 150.	BIDWELL, SHELFORD.
Electrification due to the Contact of Gases with Liquids, 73. *Discussion*, 73.	ENRIGHT, J.
Galvanometers, 348. *Discussion*, 370, 388.	AYRTON, PROF. W. E., MATHER, T. and SUMPNER, DR. W. E.
Geometrical Construction of Direct Reading Scales for Reflecting Instruments, 428.	TROTTER, A. P.
Magnetic Survey, The, 644. *Discussion*, 645.	RUCKER, PROF. A. W.
Method, A, of Driving Tuning-Forks Electrically, 17. *Discussion*, 17.	GREGORY, W. G.
Permanent Magnetism, A Theory of, 645. *Discussion*, 645.	OSMOND, M.
Shapes of Movable Coils used in Electrical Measuring Instruments, 577. *Discussion*, 578 (*see also* 589)	MATHER, T.
New Electric Radiation Meter, A, 16. *Discussion*, 17.	GREGORY, W. G.
Villari Critical Points of Nickel and Iron, 547.	TOMLINSON, H.

Royal Institution.

Meetings, 4, 438.	
Electric Welding, 624.	BRAMWELL, Sir FREDERICK.
Electro-Magnetic Radiation, 519.	FITZGERALD, Prof. G. F.
Problems in the Physics of an Electric Lamp, 393, 413, 417.	FLEMING, Prof. J. A.

Royal Society.

Meetings, 108, 159, 232, 565, 589, 613, 639.	
Determination of "*v*," the Ratio of the Electro-Magnetic Unit of Electricity, to the Electro-Static Unit, 619.	THOMSON, Prof. J. J., and SEARLE, G. F.
Effect of Tension upon Magnetic Changes of Length in Wires of Iron, Nickel, and Cobalt, 649.	BIDWELL, SHELFORD.
Rate of Decomposition of Chlorine Water by Light, 114.	GORE, Dr. G.

Royal Society of Edinburgh.

On an Accidental Illustration of the Effective Ohmic Resistance to a Transient Electric Current through an Iron Bar, 570.	THOMSON, Sir WILLIAM.

Thomson Scientific Club.

Electric Welding, 190.	HARTHAN C. E.

Digitized by Google

THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 599.—Vol. XXIV. FRIDAY, NOVEMBER 8, 1889. Price Fourpence.

NOTES.

The Institution of Electrical Engineers may congratulate itself on the success of its first experiment in dining, and we have no doubt that last Monday evening's gathering will be repeated every year. On the dinner as a whole—or rather, on the speeches delivered after it—we have commented in our leading columns; but there is one aspect of the scene which could hardly fail to strike any thoughtful observer conversant with the past history of the Institution and with the changes which have come over it in recent years. Evidently the writer of the letter signed "Telegraphy," which appears among our correspondence this week, is keenly alive to those changes, and regards them with little favour. While not endorsing everything that is said in the letter referred to, we cannot but sympathise with a complaint which is in many people's mouths, and to which he is only giving a perhaps over-emphatic but perfectly legitimate expression. The several alterations of title which this Society has undergone have all been in one direction, all conceded by the telegraphic element which was once its mainstay, and all resulting, finally, in the overshadowing and virtual extinction of that element. The title of Electrical Engineer certainly embraces the Telegraph Engineer; nominally it does so, but that it does so in reality is denied by "Telegraphy."

No wonder, therefore, that the numerous body of representative telegraph men who still remain members of the Society under its altered title should feel sore at the treatment they have received, and should now regret their magnanimity in permitting the change to take place. And this more especially if it be true, as alleged, that telegraph men, and telegraphic subjects in which they are interested, receive but scant recognition at the hands of the Council. That, however, is a fault which is capable of correction, and we rather think that Lord Salisbury's speech may help to bring it about. Evidently the noble Marquis had no knowledge of the transformation which the old Society had undergone, the better half of his interesting speech being occupied in proclaiming the political and commercial blessings which the electric telegraph has conferred upon mankind. The other half, although dealing with the distribution of electrical power, was intensely practical, and dealt not with the scientific, but with the social problems which this new rival of steam-power would be likely to solve. Those who thought the presence of the Prime Minister appropriate because of his known predilection for scientific research, would be grievously disappointed; and, perhaps, on reflection they may see in this a reason for reconsidering their attitude towards those practical, if less scientific, members of their Institution whose support has immensely contributed to its prosperity, and whose secession would be a serious blow to its prestige.

A highly sensational account appeared in the daily papers a few days ago of an accident in New York said to be due to a high-tension current from an overhead wire. Our enterprising contemporary, the *Pall Mall Gazette*, promptly interviewed Lord Crawford on the subject, and obtained his expression of opinion that it was a grossly exaggerated account. It goes without saying that our Transatlantic friends are adepts in the art of presenting a very simple story in highly picturesque language. In this case, however, the story as told bears evidence in itself that a liberal use has been made of the scientific imagination in dealing with the facts. It is quite within the limits of probability that an overhead wire belonging to a high-tension circuit should be brought down, and that a horse and his driver may have received severe shocks by becoming entangled up in the wire; but that a wire should "blaze and splutter in the gutter half an hour" *after* it has been severed from the circuit, is not to be accepted on the statement of any reporter.

We have no desire to minimise the danger existing from high-tension overhead circuits, especially when improperly or carelessly put up, or when unlooked-for catastrophes bring them down; but highly-coloured and sensational accounts of accidents so arising only alarm unnecessarily the public mind. The question of overhead wires has got to be faced, and sooner or later they will have to go underground in the United States and elsewhere. The companies need a little pressure continuously applied to bring about this result, but this influence is better brought to bear in the form of a plain and accurate statement of facts, rather than in the form of a highly-exaggerated story in the daily press.

The question of wire gauges is opened up in our columns to-day by Mr. Trotter. Committees may come and Committees may go, but B.W.G. goes on for ever, and not only goes on, but exists in some fourteen different forms, and is only rendered workable by the fact that wire-dealers generally state what they mean by their various sizes. Mr. Trotter is not quite correct, we

Digitized by Google

believe, in saying that the *universal* gauge in American is the Brown and Sharp gauge. The Association of Edison Electric Companies have a gauge of their own. In this gauge the number denoting the size of a wire is the number expressing the nearest whole number of thousands to the expression for the cross sectional area of the wire in circular mils. *Ex gr* No. 10 B.W.G. (usual) wire has a diameter of ·134in., hence its cross section in circular mils. is 17,956, and this wire would be called No. 18 E.S.G. The equivalence of area of wires is, therefore, "figured out" very quickly, and unnecessary strain on intellectual faculties of an order somewhat lower than those of a BIDDER or a BABBAGE is avoided.

MR. TROTTER has done good service, however, by pushing this subject to the front, because it is only by steady persistence that the mental inertia factor resisting desirable change is overcome, and the necessary reform effected. In this, as in so many other things, it is not approach to an ideal system, but uniformity of practice, that is most desirable. The ideal wire-gauge would be one on which calculations as to area and weight are rendered as simple as possible, but it may take some time before we get "wire gauges" and "small screws" into the position of satisfactory unity occupied by the "Whitworth screw."

MR. W. G. GREGORY'S Paper to the Physical Society on a "New Electric Radiation Meter" is an interesting account of an attempt to find a substitute for Hertz's resonator in the detection and localisation of electro-magnetic waves. Further experience with it will, no doubt, result in increasing its sensitiveness. It virtually forms another type of "artificial eye" for appreciating electro-magnetic waves. It may well happen that a physiological study of the retina of the eye, undertaken in the light of recent researches on the electro-magnetic theory of light, may result in greatly increased knowledge of the process of "seeing." We can in this connection call to mind some experiments of Prof. DEWAR'S some time ago, in which he showed that stimulation of the retina of the eye by light produced an electric current capable of being detected by galvanometric means. The electro-magnetic theory of light will have to be supplemented by an electro-magnetic theory of "seeing," at least as far as the actual organ of sight is concerned. Here is work for electro-physiologists.

MR. HAROLD P. BROWN, undaunted in spite of the revelations made by the *New York Sun*, is again on the war path. We have, a few days ago, received from this gentleman a pamphlet headed "Electrical Distribution of Light and Power," which contains a reprint of a lecture he delivered before the Medico-Legal Congress on the fourth of June last, a "partial list of deaths from electric lighting apparatus," and a reprint of an address by a Transatlantic legal luminary on "Legislative Control of Dangerous Electrical Circuits," also delivered before the Congress. If Mr. BROWN were to limit himself to the subject of rendering high-pressure currents safe, every electrical engineer would be in sympathy with him; but he has gone far beyond this mark. His experiments on animals, whilst adding absolutely nothing to our knowledge of the dangers of high-pressure currents, had the effect of alienating the sympathy of his professional brethren, and his excursions under the humanitarian cloak into commercial matters had only the effect of making shrewd business men ask themselves whether Mr. BROWN was not, after al', more concerned with the financial success of some particular system than with the safety of the public. Thus, in the pamphlet before us, we find him again at work trying to prove that the Westinghouse system has a much lower over-all efficiency than the Edison Three-Wire system, and that the latter only requires 25·91b of copper per lamp, whilst the former requires 26·81b. How this statement can be reconciled with the fact that the Westinghouse system has been successful in localities which were hopelessly beyond the reach of the Three-Wire system, we must leave Mr. BROWN to explain.

Burnley.—The Town Council has decided to apply for an electric lighting Provisional Order.

Wigan.—Application is to be made by the Town Council for an electric lighting Provisional Order.

Chelmsford.—At a special meeting of the Town Council last week, the draft licence of Crompton and Co. (Limited) was approved of.

Bucharest.—A 40 years' concession has been granted to a local company for the public and private lighting of a portion of the town.

Walthamstow.—At the last meeting of the Local Board, it was agreed to take steps towards the erection of a central lighting station.

Praham.—It has been decided to introduce the electric light into Praham (Victoria). Messrs. Booth, Ellson, and Co. will probably undertake the work.

Paisley.—At a special meeting of the Council, held on Friday last, it was agreed to apply for a Provisional Order to light the town with electric light.

Wolverhampton.—At a special meeting of the Town Council on Friday last, it was decided that the Corporation should apply for an electric lighting Provisional Order.

A New Use for Electric Motors.—The American Treasury are about to employ electric motors to run the punching machines for cancelling redeemed Treasury notes.

The Woodhouse and Rawson Wiring Tables.—These tables are ready, and can now be obtained from Messrs. Woodhouse and Rawson United, or at the office of *The Electrician*.

Temesvar.—Considerable excitement was caused in Temesvar on Monday night owing to the failure of the electric light. It is reported that some of the underground mains were fused.

Contract Open.—For a complete electric light installation for works in Queen's-road, Victoria Docks, E., for Messrs. W. Goodacre and Sons, Abbey Mills, West Ham, E. Apply to above firm.

Electric Traction in Spain.—Before the close of the year the Bilbao and Portugalete tramway will be worked by electricity. The Madrid Stations and Markets Tramways Company are also going to try the accumulator system.

The Birmingham Exhibition.—The Electrical Exhibiton at Bingley Hall closed on Thursday last week. The Exhibition has been declared a success, and a substantial sum, it is anticipated, will be handed over to local charities.

Machinery Notes.—Ransomes, Sims, and Jefferies (Limited), of Ipswich, are, we hear, extremely full of work in their engine department, having large orders in hand for all classes of engine work, including electric light and mining machinery.

University College, Liverpool.—The Walker Engineering Laboratories at the University College, Liverpool, which have been built and furnished by the liberality of Sir Andrew B. Walker, were opened on Saturday last by Lady Walker.

Digitized by Google

Repeal of Chilian Import Duties.—According to the *Financial News*, the Chilian Government has decided that after January 1st no import duties will be charged on tools, machinery, railway plant, or telegraph or telephone material.

The Telephone in Russia.—The Vienna correspondent of the *Daily News*, writing from the Russo-Polish frontier districts, reports that the different railway stations are being connected by telephone, which spreads to all the military garrisons near the frontier.

An Addition to the Customs Free List in Natal.—A law enacted by the Governor of Natal provides for the admission into the colony, free of Customs duty, of materials required for the construction and maintenance of telegraphs in the Orange Free State and the South African Republic.

Hastings.—The Town Council on Friday last renewed for another year the existing contract with the Electric Light Company for the lighting of the front line from the Queen's Hotel to Warrior-square by fifteen 2,000 nominal candle-power arc lamps, for the sum of £450 per annum.

Deputations at Taunton.—A deputation recently visited Taunton from Barnsley to inspect the electric lighting of the streets. The deputation was unanimous in the opinion that the electric lighting at Taunton was the best that they had seen. Subsequently another deputation arrived from Carlisle.

The French Telegraphs.—The Directeur-Général des Postes et Télégraphes having become aware that the French Telegraph service is inferior in point of rapidity of transmission, and in many other respects, to that of England and Germany, has nominated M. Fribourg to study the question of reorganisation.

Wolverhampton.—The Corporation have refused to grant their consent to the application of the Wolverhampton Electric Light and Power Company, and of the Midland House-to-House Electricity Company, for Provisional Orders. The Corporation have determined to make application for an Order on their own account.

Ramsgate.—The Corporation has decided to take every means of opposing the granting of a Provisional Order in favour of any electric light company. Several members of the Corporation expressed themselves to the effect that it would be suicidal policy to admit the electric light so long as they were proprietors of the gasworks.

Royal Institution.—At the general monthly meeting of the Royal Institution on Monday last, the special thanks of the members were returned to Prof. Dewar, F.R.S., for his valuable present of a portrait of the late Mr. Henry Pollock, and to the Rev. John Macnaught, M.R.I., for his second donation of £50 for improvements in the building.

The Halifax-Bermudas Cable.—On the completion of the cable between Halifax, Nova Scotia, and the Bermuda Islands the British Government proposes to establish a meteorological station at the latter place; and the Government of Canada, in view of the fact that it would be of value to them, are stated to bear half the cost of establishing the station.

British Association Screw Thread.—Mr. Lehmann desires us to say that his address is 38, *not* 28, Hampshire Street, Torriano Avenue, N.W., as it appeared in the report of the proceedings of the London Chamber of Commerce last week. Mr. Lehmann adds that he has been for over five years, and is now, exclusively devoting himself to the practical working out of the Standard Screw Thread.

The Siemens' Five-Wire System.—The municipal authorities of Königsberg are about to carry out an 8,000-light installation on the Siemens' five-wire system, combined with Tudor accumulators. The mains are to be copper rods, resting on porcelain insulators and laid in cement conduits. Three towns will now shortly have the five-wire system in operation, viz., Königsberg, Vienna, and Trient.

Hull.—At the last meeting of the Works Committee it was decided that the Town Council should be recommended to consent to the application of any electric light company prepared to give an absolute undertaking to withdraw their application at any time at the Corporation's request, and that failing such undertaking the Town Clerk should be authorised to apply for an Order on behalf of the Corporation.

Dundee.—The Committee of the Dundee Gas Commissioners has issued a report recommending that the Gas Commission should undertake the introduction of the electric light into Dundee. It has further been decided that the Town Council should apply for power under a special Act to enlarge the representative basis of the Gas Commission, and after that representation had been secured to apply for power to supply electric light.

The Edinburgh Exhibition.—In the Edinburgh Dean of Guild Court last week Mr. R. A. Robertson, on behalf of the executive committee, moved for a warrant to proceed with the erection of the buildings of the Edinburgh International and Electrical Exhibition. The Dean of Guild said he would be prepared to sign the plans as soon as an arrangement was come to with the railway company. The warrant was granted on this understanding.

Military Telegraphists in India.—All the telegraph wires north of Lahore, says *Indian Engineering*, have been placed under the control of Royal Engineers. Soldiers work the line, and officers will be placed in charge, the whole, however, being under the Assistant Superintendent of Telegraphs of that division. Officers will serve until they become proficient in telegraphy, and then they will be succeeded by others. By this means, it is hoped, a large number of officers and men will be well posted in the working of the telegraph.

The Copper Market.—The deliveries of copper during October, according to Messrs. Merton and Co.'s statistics, were as much as 13,890 tons, and the visible stock in England and France and afloat is now reduced to 103,540 tons. At the end of last March the corresponding stock similarly in sight was 124,876 tons, which was the maximum. The rate of decline since that date has therefore been fully 3,000 tons per month. The increase of consumption during October is the more remarkable in connection with the rise of the price of copper, which is now over £44, compared with less than £38 per ton last April.

Lightning at Malta.—The Deputy Governor at Malta has appointed a commission for the purpose of inquiring into and reporting upon the circumstances attendant upon the death by lightning which took place near Rabato, Malta, on the night of the 29th ult., and with reference to the danger or inconvenience which may, in certain cases, result from telegraph or telephone wires fixed against inhabited buildings. The members of the commission are: The Hon. G. C. Schinas, Ph.D., C.E., Superintendent of Public Works; Prof. S. L. Pisani, M.D., Chief Government Medical Officer; Captain Middlemass, R.E.; Prof. H. Magro, M.D.; John McGill, Esq., Eastern Telegraph Company.

Exeter.—Much inconvenience has been caused by the electric light at the theatre suddenly going out on several occasions. For the first two weeks the lighting was very satisfactory, but it is now quite otherwise. On Saturday last (November 2nd) the lights were out for about an hour. The fault is supposed to be in the armature of one of the dynamos. The annual inspection of the Exeter Fire Brigade by the City Council took place on Saturday (November 2nd) when the electric street fire alarms which have only been recently completed, were inspected and tested. The contract for supplying and fixing these alarms has been successfully carried out by Mr. H. J. James, of Exeter.

Edinburgh.—At a special meeting of the Edinburgh and Leith Gas Commissioners, held on Friday last, the Works Committee recommended that they adhere to their former resolution, refusing the Commissioners' consent to any electric lighting company obtaining powers, and that they resolve to oppose any applications for such powers. This was adopted, Bailie Archibald remarking that they must let the ratepayers understand that all the property of Edinburgh and Leith was mortgaged and pledged for the value of the gas to the amount of upwards of one million sterling. There were plenty of places where the electric light companies could try their experiments without coming to Edinburgh.

The Maritime Conference at Philadelphia.—The Committee on Nautical Devices report that they have considered 37 different proposals on night-signalling at sea, but none are equal to the

Digitized by Google

Morse system now in use in many navies, including those of Great Britain, France, and the United States. The Committee also recommend that there should be a fixed *minimum* standard of power for all lights, and, while electric incandescent lamps should be permitted, the use of the arc light at present should be excluded, except for signalling and search lights. One amendment has been carried which provides that the lights carried by ships laying telegraph cables shall be in globular lanterns, instead of a white light, and shall be of a power visible for at least two miles' distance.

Paris Exhibition Honours.—Among the British subjects who receive promotions in or are nominated to the Legion of Honour in connection with the Paris Exhibition are:—Grand Officer of the Legion of Honour: Sir William Thomson, F.R.S. Officers of the Legion of Honour: Sir Douglas Galton, K.C.B., Sir Henry Roscoe, M.P., F.R.S., Mr. James Dredge, Mr. W. H. Preece, F.R.S., Mr. H. J. Trueman Wood, Mr. J. Aylmer. Officers of Public Instruction: Mr. C. V. Boys, F.R.S, Mr. W. H. Massey. Among the French electricians who have been decorated are M. Mascart, who has been made Commander of the Order of the Legion of Honour; MM. Hippolyte Fontaine, Gariel, Menier, Potier, and Weyher, Officers; MM. Berthon, Cance, Lecouteux, Desroziers, Mouchel, Richard, Rouart, Sautter, and Sciama, Chevaliers.

Concession for Costa Rica Cables.—The *Bulletin de l'Electricité* states that the Government of Costa Rica has authorised Señor D. V. Cuenca Creus, concessionnaire of the proposed submarine cables between Venezuela and the United States, to establish direct or indirect telegraphic communication by means of one or several submarine cables with some point on the Atlantic coast of the Republic. The system may touch at one or several points in Central or South America which are as yet unconnected by telegraph on the Atlantic coast of Costa Rica. The concessionnaire binds himself to connect his system with the Atlantic cable which it is proposed to establish between Cuba, Spain and France, *viâ* the Canary Islands. The Costa Rica Government guarantees an annual amount of £1,400, and reserves to itself the right of intervening in the arrangement of tariffs and in the service regulations.

Launceston (Tasmania).—The Launceston City Council have been advertising for tenders for the electric lighting of the city, and have received an offer from the Australian consignee of Ganz and Co. He proposes to utilise water-power to generate the current, which will be sufficient at first to supply 5,600 incandescent 16-candle lamps. The whole of the plant for the installation is offered to the Council for £23,000, which is, of course, exclusive of building, tail-water channel, excavations, and masonry work. The approximate annual cost is put down at £9,554. Another firm have offered to light the city by electricity as a distinct undertaking, or in conjunction with a tramway system, if the Corporation will grant the use of the streets for a sufficient term; but no figures have been submitted. The whole matter awaits a report from the Committee of the Council, to whom it has been referred.

The Relation between Magnetic Disturbances and Earthquakes.—In a note in a recent number of the *Comptes Rendus*, M. Mascart reports that M. Moureaux, who has charge of the magnetic observations at Saint-Maur, has informed him that the magnetic curves for October 25th show indications of disturbances similar to those which have previously been noticed on the occasion of earthquakes, although on that day a copper bar attached to a bifilar suspension did not show the slightest deflection. Since this the papers have announced an earthquake which caused considerable destruction at Gallipoli, and which, from all accounts, seems to have taken place at the moment when the magnetic disturbances were observed at Saint-Maur. If further information confirms the simultaneity of the two events, it would seem that the disturbances of magnetic instruments are not due—in some cases, at any rate—to the mechanical transmission of the shock.

Mica and Glass as Insulators.—Some years ago Warburg showed that when a layer of glass between two mercury electrodes is traversed by an electric current a badly conducting layer of silica is deposited on the side next the anode, and this layer acts just like the dielectric of a condenser, of which the mercury and the glass may be regarded as the two coatings. The result of this phenomenon is that the insulating power of glass at high temperatures increases with the temperature, and at sufficiently high temperature its surface conductivity is reduced to a very small value. Schultze has recently made some similar experiments on mica, which are of considerable practical interest owing to the numerous purposes for which this material is now employed. Schultze's experiments were all made upon sheets of mica split along the plane of cleavage, and he found that their behaviour was exactly similar to that of plates of glass, viz., the first effect of a rise in temperature was to increase the conductivity up to a definite maximum value, after which further increase in the temperature caused a large diminution in the conductivity, which seemed indeed to approach the value zero at very high temperatures. In comparing the insulating powers of mica at various temperatures, both with white mirror glass and thin watch glass, Schultze found that at all temperatures mica was the better insulator.

Mineral Indiarubber Asphalte.—This is the name of a new material, composed of the hitherto valueless refuse of tar, produced during the refining process of tar by sulphuric acid. This secondary produce forms, according to the *Indiarubber Journal*, a black stuff very much like ordinary asphalte, and quite as elastic as indiarubber. If heated in a stove to such an extent that the slimy matter is reduced to, say, 60 per cent. of its former size, a substance is gained as hard as ebony, and dissolvable in naphtha, an excellent non-conductor of electricity, unassailable by acids and alkalies, and therefore very suitable as coverings of telegraph wires and cables. The solution of the mineral indiarubber asphalte, either in naphtha or petroleum, yields a waterproof varnish which remains firm upon metallic objects. The manufacture of the article pays extraordinarily well, as the following figures, taken from the "Société Oleo-Graisse," the inventors and only manufacturers of the material, amply prove:—

	Cost of production per ton. Shillings.	Selling price per ton. Shillings.
Asphalte	16	80
Varnish	16	80
Substitute of ebony	160	1,200
Raw electrical isolating matter	32	400

In the petroleum districts the raw material is almost inexhaustible, and the indiarubber industry has consequently every opportunity of utilising the tar refuse.

The Electrical Conductivity of Saline Solutions.—Numerous experiments on the electrical conductivity of saline solutions have been made by M. P. Chroustchoff. The methods were applied to mixtures of different salts in equivalent proportions. The conclusions arrived at are as follows:—(1) Starting with any system of two salts, the same conductivity is obtained as with the inverse system; (2) the conductivity of the mixture is not the mean conductivity of either system of two salts, nor is it intermediate between the two mean conductivities, but is generally lower than either. This points to a reduction in the number of conducting molecules in the liquid, or, in other words, to the formation of double salts. The typical reaction as represented by the ordinary equation for double decomposition is rarely met with, and in almost all cases the change is complicated by secondary reactions. Other experiments were made with mixtures of two salts which were not likely to interact. The conductivity of each solution was determined separately, and they were then mixed in equivalent proportions. In some cases the observed conductivity of the mixture is the mean conductivity of its constituents; in other cases it is lower. It follows that with the degree of dilution employed there is a reduction in the number of conducting molecules, either by formation of double salts, as with some of the sulphates, or by dissociation by the water, as in the case of zinc acetate. The *Journal* of the Chemical Society points out:—"It is noteworthy that, as a rule, mixtures of salts which crystallise with water have the mean conductivity of their constituents, whilst the conductivity of mixtures of salts which form anhydrous crystals is below the mean."

Digitized by Google

A COMPARISON BETWEEN THE CONTINENTAL, AMERICAN, AND ENGLISH DYNAMO-ELECTRIC MACHINERY.

BY ALBION T. SNELL.

(*Continued from page 647.*)

Amongst the Continental machines there are a few designs which differ from those types usually regarded as normal. I say normal because, with the exception of the Dezrozier and the *outside armature* Alsacienne dynamos, most of the machines previously referred to belong to types sufficiently common in England to be accepted in ordinary practice. There seems to be in France, as well as in America, a desire to depart from existing types; although such departures oftentimes hint at a want of due appreciation of the advantages of simplicity of design, novelty is good, and if the fundamental principles demonstrated by a costly experience are not neglected to gain the desired end, there can be no objection to the departure. I cannot help thinking, though, that some of the machines shown at the Exhibition have gained novelty at the expense of some of the most important features of design. I will leave the reader to judge whether such be the case, only referring to some of these machines.

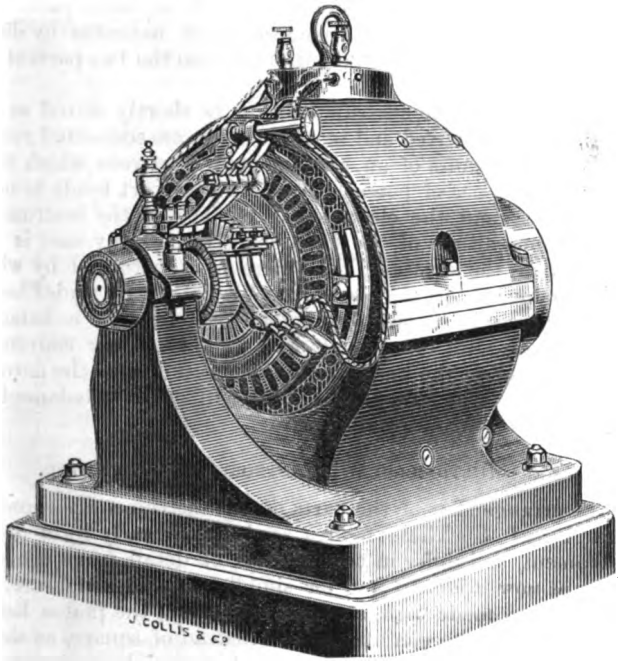


FIG. 6.—The Alioth Dynamo

The Société Gramme have several dynamos designed by M. Deprez. These differ from normal practice in having two armatures to one system of field-magnets, the *second* armature running in the space usually occupied by the yoke. Each armature is independent of the other, as far as the electric and magnetic conditions. Indeed, if mechanical considerations did not make it convenient to mount the two armatures on the same shaft, the dynamo might be considered as two separate machines, and one armature might be run without reference to the other. Since one field is made to excite two armatures, it appears at first sight as if the output per pound of material were largely increased over the normal type. But the double air-gap involved must increase the magnetic resistance of the system very considerably, and necessitates a far greater excitation for a given magnetic density in the armatures. The weight efficiency would thus be probably little, if any, higher. The cost of production must be increased, for the most expensive parts—the armature, commutator, and brushes—are in duplicate. As a set-off to these, there is the advantage that a break-down of one armature will leave the other unimpaired, and space would undoubtedly be economised. This design is also adapted to the multipolar type.

The armour-clad four-pole dynamo of the Alioth Company (Fig. 6) is well worthy of note where a large stray magnetic field is likely to do harm. Mechanically, the design is excellent, for the armature and field windings are entirely surrounded by the circular yoke and the handsome end-covers. The ventilation would appear to be the chief difficulty. This depends almost entirely upon the circulation of air through these covers. To increase this effect, the windings do not entirely cover the periphery of the armature, and spaces are left between the plates at suitable intervals to allow a free circulation of air from the shaft outwards. This manner of ventilating armatures has been patented more than once, and tried with indifferent success by most of the better-known firms. I think, however, that most of them have abandoned the scheme after a few years' trial, preferring to depend on surface rather than internal cooling. An armature is, in the very nature of things, weak, being built up of so many parts. The insulating materials, too, are very uncertain, and generally shrink sooner or later. From the engineering point of view, I much prefer an armature solidly built, with the plates as closely pressed on the insulation as possible, and the whole of the periphery covered with sound insulation and tightly packed wire. The iron plates used in these armatures are one-sixteenth of an inch thick. Judging from my experience, I should anticipate a very heavy loss from Foucault currents, and do not feel surprised that internal ventilation is resorted to on this score alone. The winding is of the drum type and is splendidly finished, each coil being shaped independently in a wood mould.

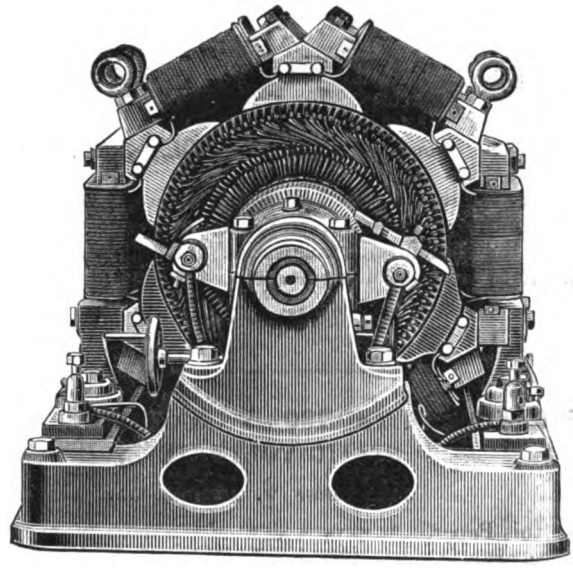


FIG. 7.—The Thury Six-Pole Dynamo.

I shall refer to this when discussing armature winding. Basing my opinion on these criticisms, I should think the weight efficiency was low.

The Thury machine (Fig. 7) is made by Messrs. Sautter et Cie. They exhibit some well finished slow-speed six-pole dynamos, with cylinder armatures and wrought-iron fields of hexagon shape. One of these dynamos, weighing 9,900lb., gives an output of 88,000 watts at 300 revolutions per minute. The surface velocity of the armature is about 2,350ft. per minute. The output is thus very high, 67lb. giving one electrical horse-power. This high weight efficiency is gained by the lavish use of tooled wrought iron in both yokes and cores. Indeed, the field is almost an ideal one from the magnetic point of view. Whether it pays to build such a costly arrangement to gain this efficiency is matter for argument. In England and America the cost of labour would prohibit the design. The illustration will make this clear. The engineering is of the highest order. The joints of the yoke-pieces and the cores are splendidly finished.

Messrs. Sautter, Lemonnier, et Cie. show several cylinder dynamos of the double-field type, with cast-iron pole-pieces and wrought-iron cores (Fig. 8). In these machines apparently cost of production has been kept steadily in view, the result being

Digitized by Google

a somewhat rough-looking, though undoubtedly serviceable, dynamo. The only point I wish to specially note is the radial recessing of the edges of the pole-pieces. This lessens the area of the face of the pole-piece. I assume the makers have found some difficulty with the connections between the armature coils and the commutator. These are a source of considerable trouble with some machines. Connections are continually breaking without any apparent reason. There are two main conditions which appear to cause these breakages. The first is a spring in the shaft, throwing a purely mechanical strain on the connections. The second is the fringe of magnetism around the edges of the pole-pieces, which may cause some considerable work on the adjacent connections. The remedy for the first

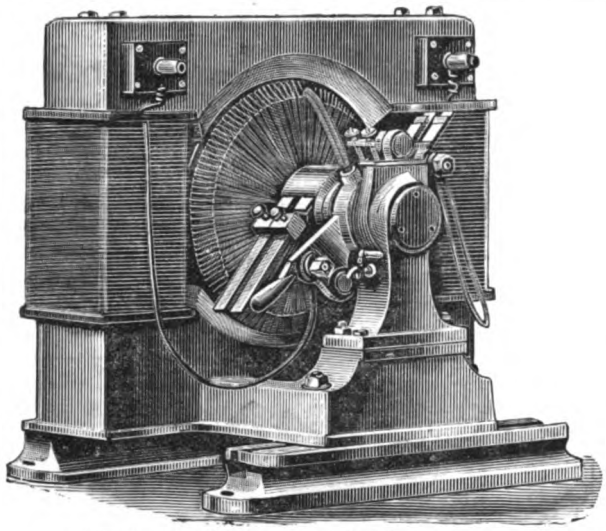


Fig. 8.—The Sautter-Lemonnier Dynamo.

evil is self-evident. The second may be overcome by a suitable arrangement of pole-piece and armature core. I have never known the commutator connections of an Immisch motor or dynamo to break with fair usage.

(To be continued.)

SIR WILLIAM THOMSON'S CHAIN OF ELECTROSTATIC VOLTMETERS.

BY ANDREW W. MEIKLE, M.A.

In this Paper it is proposed to give a description of a chain of electrostatic voltmeters invented by Sir William Thomson, and also to give an account of the methods employed in standardising them. These voltmeters have the great advantage of being equally available as accurate measures of potential on direct and alternating systems; and, being electrostatic, they use no current, and consequently require no temperature correction. They are, therefore, free from the causes of error so prevalent in instruments of the electro-magnetic type, whose accuracy is impaired by variations of temperature, and when used on alternating systems there are errors due to self-induction which vary with the period of alternation. The chain of electrostatic voltmeters measures from 20 to 50,000 volts, and is composed of three distinct types, viz., the Multicellular Electrostatic Voltmeters, the Vertical Scale Electrostatic Voltmeters, and the Electrostatic Balance. The ranges of the separate instruments as usually made are :—

Multicellular Electrostatic Voltmeter	range	20 to	100 volts.
	best of range	25 to	75 volts.
Multicellular Electrostatic Voltmeter	range	40 to	160 volts.
	best of range	50 to	100 volts.
Multicellular Electrostatic Voltmeter	range	60 to	240 volts.
	best of range	70 to	130 volts.
Multicellular Electrostatic Voltmeter	range	80 to	400 volts.
	best of range	100 to	240 volts.
Multicellular Electrostatic Voltmeter	range	200 to	800 volts.
	best of range	300 to	600 volts.
Vertical Scale Electrostatic Voltmeter	range	400 to	8,000 volts.
Vertical Scale Electrostatic Voltmeter	range	800 to	12,000 volts.
Electrostatic Balance.....	range	2,500 to	50,000 volts.

The Vertical Scale Voltmeter has been in use for about three years, but as the demand for it has lately increased since high potential systems have become so numerous, a few words of explanation about its construction and standardising may not be out of place here. It has therefore been included along with the later types in the present description.

Before describing the instruments separately, it may be well to notice some points which concern them all.

The instruments are made on the principle of an air condenser, having one of its parts movable about an axis, so as to increase or diminish the capacity. The condenser is enclosed in a metal case for the double purpose of protecting the movable parts from air-currents and from the disturbing influence of any electrified body other than the fixed portion differing from it in potential. In all the instruments, except the electrostatic balance, the fixed portions consist of two sets of quadrant-shaped cells, in metallic connection with each other, and formed by a number of parallel brass plates. These cells are fixed by an insulating support to the case of the instrument, and a terminal passes from them to an insulating binding screw on the outside of the case.

The movable portions in all the instruments is in metallic connection with the surrounding case. In the Multicellular Voltmeters this connection is made though the suspending wire, and in the Vertical Scale Voltmeter and Electrostatic Balance through the knife-edges, which support the movable part. The movable portion carries the pointer, which indicates by direct readings the difference of potential between the two parts of the condenser.

The action of the instrument may be shortly stated as follows:—When the fixed and movable plates are connected respectively to two points of an electric circuit, between which there exists a difference of potential, the movable part tends to move so as to augment the electrostatic capacity of the instrument, and the magnitude of the force concerned in any case is proportional to the square of the difference of potential by which it is produced. In the use of the Vertical Scale and Electrostatic Balance instruments, this force of attraction is balanced by the horizontal component of a weight of any convenient amount hung on the knife edge in connection with the movable part, while in the case of the Multicellular it is balanced by the torsion of the suspending wire.

The Multicellular Electrostatic Voltmeter.

The arrangement of the parts of this instrument is shown in Figs. 1 and 2. These figures apply to an early form of the instrument, and differ in two matters of detail from the voltmeter as now made. First, for simplicity in manufacture, the cells are now made with straight backs, and the plates looked at in plane are therefore triangular instead of square, as shown in Fig. 2; second, a coach spring has now been interposed between the suspending wire and the spindle carrying the vanes, as explained below. The insulated cells are formed of triangular brass plates fixed into saw-cuts in a brass back piece, so as to be equal distances apart, and accurately parallel to each other. Two sets of these cells, C, are fixed relatively to each other, as shown in Fig. 2, by a vulcanite support to the sole plate, so that their plates are horizontal, and are completely enclosed within the brass cylindrical case of the instrument. On the top of this cylinder is a shallow horizontal circular scale-box containing the scale of the instrument, and having a glass cover, which serves to protect from currents of air the movable indicator I and the scale and interior parts from dust. For the movable part a number of vanes, V, similar in form to those of the quadrant electrometer are used. These vanes are placed parallel to each other on a spindle with distance-pieces between them. The top end of this spindle passes through a small hole in the sole-plate of the instrument, which forms the bottom of the scale-box, and is attached to a small coach-spring, which in turn is secured to one end of a fine platinum wire suspended from a torsion head at the top of a vertical brass tube. The torsion head may be turned by means of a forked key provided for the purpose, and is clamped, to protect it from accidental displacement, by a cap which screws on to the end of the tube. The coach-spring has sufficient resilience to allow the spindle to touch a guard stop, and so

Digitized by Google

aves the suspension from injury in the event of the instrument being roughly set down. Two vertical brass repelling plates, which also act as guard plates to prevent the movable part from turning beyond its prescribed limits, are fixed to the bottom of the sole plate. These two plates carry a guide plate, G, with a circular opening in it, through which the lower end of the spindle passes. A little brass disc, D, or head, is attached to the end of the spindle, sufficiently large to prevent its passing back through the hole in the guide plate. Thus the movable part is effectually secured from swinging about so as to be injured, and by no possibility can it come into contact with the insulated quadrants. When the instrument is level the spindle hangs free by the suspending

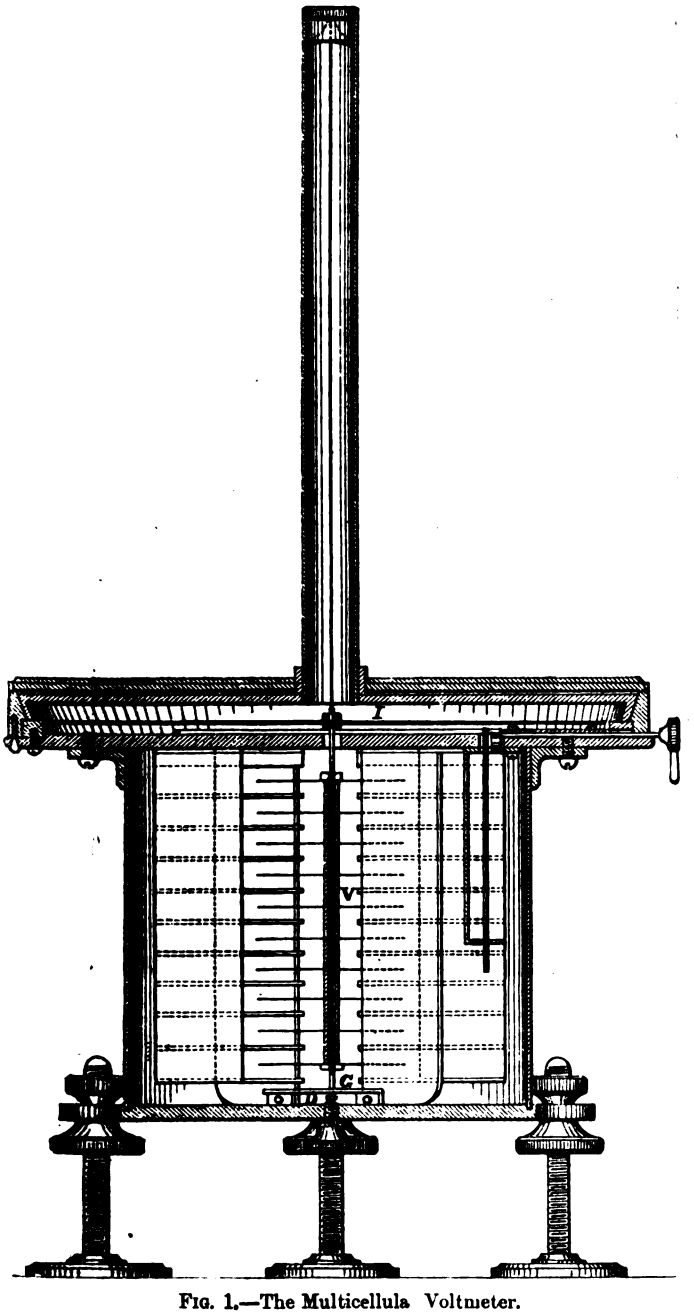


FIG. 1.—The Multicellula Voltmeter.

wire, so that the vanes are horizontal, and each is in a plane exactly midway between those of two contiguous condenser plates. To facilitate the use of the Multicellular as a portable voltmeter, a small thumb-screw is placed in the centre of the base plate below the instrument, which can be screwed in so as to lift the weight of the spindle and vanes from the suspending wire and clamp the disc on the end of the spindle against the guide plate. The instrument is also provided with a "lifter," which serves to raise the weight of the movable part from the suspending wire when it is being moved about from place to place. This lifter is in the form of a ring placed below the needle, and may be raised or lowered by turning the handle attached to an eccentric passing through the side of the instrument on a level with the scale. It also serves as a checker, by bringing it lightly into contact with the pointer, so as to stop its vibrations. An aluminium needle, I, attached to the top of the spindle, indicates, on the horizontal circular scale fixed to the upper side of the sole plate, the difference of

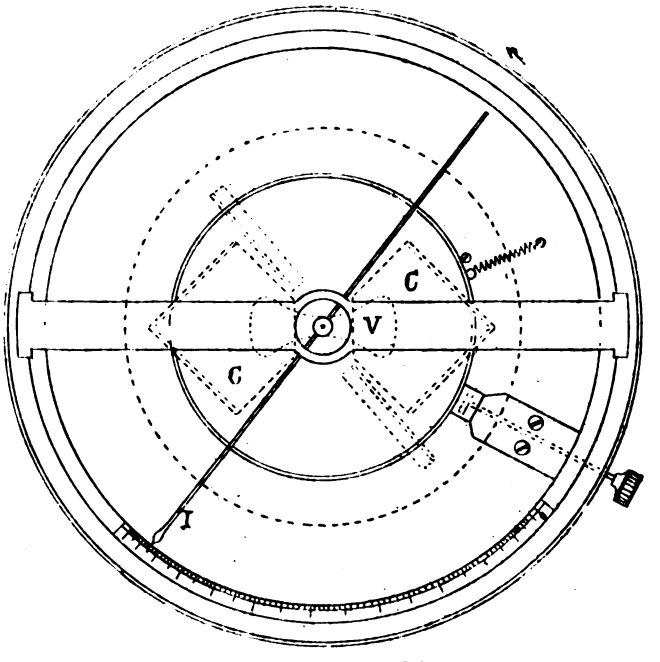


FIG. 2.—The Multicellular Voltmeter.

potential between the movable and fixed portions of the condenser by direct readings in volts. To enable this multicellular to be used as an inspectional instrument capable of being read from a distance, as across an engine room, a mirror, supported

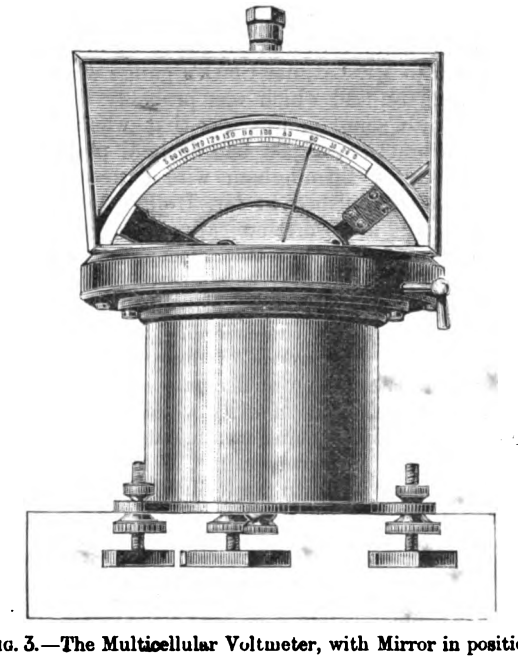


FIG. 3.—The Multicellular Voltmeter, with Mirror in position.

in a frame which passes over the vertical brass tube and rests upon the glass cover of the instrument, is supplied. When this mirror is in position it is at an angle of 45° with the plane of the sole plate, and by reflecting the scale and pointer, gives the instrument all the advantages of a vertical scale. The instrument is shown in Fig. 3 with its mirror in position.

The different sensibilities required for the different types of this instrument are obtained by varying the number of cells and vanes, and also by using suspending wires of different cross section.

(To be continued.)

Digitized by Google

WIRE GAUGES.

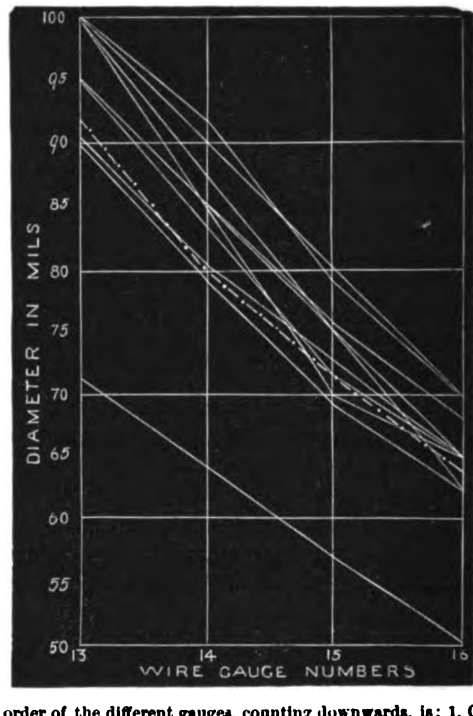
BY ALEX. P. TROTTER.

Just ten years ago there was published by the Society of Telegraph Engineers a report of their Committee on the Birmingham Wire Gauge, together with Papers on the same subject by C. V. Walker and by Latimer Clark. The report describes some fourteen different gauges, and goes into the history of the subject. It suggests that the origin of the numbers by which the sizes are denoted, is based on the number of times which the original rod had passed through the draw-plate. Mr. Latimer Clark points out that, on the one hand, the manufacturer would naturally endeavour to draw down as small as possible at one operation, in order to save labour; on the one hand, he would be limited in this by the strength of his men or the machinery in use before the introduction of steam power, and by the cohesive strength of the material itself. It is not surprising, if this explanation be the correct one, that the sizes of the Birmingham wire gauge, as given by twelve different authorities in an appendix to Mr. Latimer Clarke's Paper,* should differ considerably among themselves, while they all follow a fairly general law. This law the author attempts† at some length to prove to be a logarithmic series; he accounts for variations from it by peculiarities in the physical properties of metals, and adds that had all the wires from which the Birmingham wire-gauge series were originally drawn been perfectly pure and homogeneous, there can be no doubt that the succession of numbers would have had a common factor of reduction, and formed therefore a logarithmic curve. He suggests, then, as the basis of a new standard gauge, a logarithmic series, in which at any part of the scale the weight of the preceding size is 25 per cent. greater, and the succeeding 20 per cent. less, than the size from which one starts. The Committee selected this gauge from the thirteen others, and recommended its adoption as a standard, since, being a geometrical system, it can be extended indefinitely in either direction, and a person knowing the weight or conductivity of any one size can readily calculate the others. They pointed out that it conforms closely to most of the Birmingham gauges, although the extreme numbers, both large and small, exceed the ordinary Birmingham gauge by more than one size. One objection to Mr. Latimer Clark's gauge which was noticed by the Committee, and which was probably the reason why it never came into common use, was that when defined in mils it requires in practice at least one decimal place. Among the numerous so-called Birmingham wire gauges was one whose dimensions were published in Mr. Holtzapffel's book on Turning, and his well-known mechanical accuracy gives considerable weight to the authority of the table;‡ but even this is far from a regular series, as may be seen by plotting it on a curve, or by taking the differences between the successive sizes. The arbitrary irregularities of the different gauges on the one hand, which might make a difference of many thousand pounds to a contractor, and the numerous decimals of the geometric series on the other, was a choice of evils which the recommendation of the committee did nothing to alleviate.

In America the universal gauge, if the expression be permissible, is that of Brown and Sharp. This appears to be ill-suited to that country, for it is a geometric gauge, each size being multiplied by 0·890522 (or deducting 10·9478 per cent.) to form the next size. This involves the use of a considerable number of decimals, the usual table§ being carried to five places. If one may attempt to use their expressive vernacular, while you are figuring out a lot of peaky decimals a practical man will locate a 10,000-light plant right away. A more suitable gauge for our Transatlantic friends would be one whose sizes are denoted by fractional parts of an inch. One could then make two cuts on a hammer handle, wind the wire round and round, and then count the turns.

The Post Office has for many years specified the size of iron telegraph wires by the weight per mile. This system presents the advantage of the use of a unit which is directly proportional to the conductivity and cost; but it is applicable to only one material. In such manufactures as rabbit netting, wire rope, needles, &c., only a few sizes are required, and the maker would probably detect any variation in the diameter by comparing the dimensions or bulk of the finished article with its weight; but during the last five or six years the development of the manufacture of dynamos and electrical instruments has made the exact specification of the diameter of wires an absolute necessity. Five years ago, Gramme armatures were wound with 400ft. of No. 18 per arc lamp, and four or five mils or so one way or the other did not matter in the least. But nowadays the utmost nicety of calculation is often needed to bring a dynamo within the limits of weight prescribed by the Admiralty, or to squeeze a stock size to meet an intermediate output. Again, to calculate a special shunt-winding for a specified output and speed implies the use of an accurately determined size or sizes of wire.

The ambiguity existing among the fourteen versions of the B.W.G. at first sight appears to be serious, but now that every electrical wire dealer gives a table of the sizes expressed in decimals of an inch, the difficulty, as far as the execution of orders is concerned, vanishes. In other trades where the inconvenience of ambiguous gauges has been felt, the example of the electrical trades may be followed, and the diameter may be specified in mils.



At 13¾ the order of the different gauges, counting downwards, is: 1, Cocker [steel] (*The Electrician*, Vol. II., p. 286.); 2, Cocker; 3, Schaw (*The Electrician*, Vol. II., p. 8); 4, Bartholomew; 5, Whitworth, Henley, Culley, Rylands (*The Electrician*, Vol. I., p. 191); 6, Holtzapffel [also Stubbs]; 7, Latimer Clark; 8, Board of Trade S.W.G.; 9, Rylands, 1866, Brown and Sharp.

At 15½ the order is: 1, Cocker; 2, Cocker [steel] (*The Electrician*, Vol. II., p. 286); 3, Bartholomew; 4, Henley, Culley, Rylands (*The Electrician*, Vol. I., p. 191); 5, Schaw (*The Electrician*, Vol. II., p. 8); 6, Latimer Clark; 7, Molesworth; 8, Board of Trade S.W.G.; 9, Whitworth; 10, Rylands, Brown and Sharp.

But certain authorities discovered, either by pure deduction, or by observation of some dispute or litigation, that a contract merely specifying a certain size of B.W.G. was loose, and even a judge and jury could not determine its exact meaning, although the inch, and therefore the thousandth part of an inch, yet remains as an imperial measure by which the contract might have been exactly particularised. They, therefore, by way of mending matters, devised the S.W.G., and in March, 1884, it became a legal measure. At that time the writer, who was then commencing to build dynamos, thought that the general introduction of the new gauge would be a matter of a few years, and to avoid future trouble he adopted it at once. Some time elapsed before he discovered that the wire, which was carefully specified in S.W.G. and in mils, was specially drawn for his firm, whose order would have been executed, at all events in part, from stock the next day, had B.W.G. been specified, but who were generally kept waiting for

* British Association, Dundee, 1867.
† British Association, Exeter, 1869.
‡ "Electrical Trades' Directory," p. lvi.
§ "Electrical Trades' Directory," p. lvi.

Digitized by Google

weeks. Plotting on a curve (see diagram), the standard gauge, together with the different versions of the B.W.G., the former is found to follow the general sweep of the latter more closely than does Latimer Clark's logarithmic gauge. But the sizes are smaller than the various B.W. gauges. If this had been intended as a restoration of the great original B.W.G., the difference might be due to an attempt to eliminate the effects of wear on the notches by which wires are measured, but there is no reason to suppose that this is the case. A careful inspection of the figures show that the differences run in groups, and do not give a gradual increment, as in geometrical systems. For example, between 23 and 19 the diameters increase by 4 mils, between the next four sizes 8 mils, the next two sets of four—that is up to No. 7—by 12 and by 16 mils respectively; then three sizes differ by 20 mils, and then a group of five with an increment of 24 mils. Decimals of a mil are not required above No. 27. The S.W.G. is convenient, since it closely follows the sweep of the numerous versions of the B.W.G., and it is sensible in its method of increase and in its freedom from decimals; but there its value seems to stop. Were it universally adopted, there would, doubtless, be little or no fault to find with it, but where is the inducement to adopt it? From the legal point of view, surely, a contract which specifies the diameter in decimals or fractions of an inch is sufficiently explicit, and it is questionable whether a wire dealer who issues a printed list containing two columns, one of B.W.G., the other of dimensions expressed in parts of an inch, would not be held to his list in a court of law if his customer had merely specified a certain number "B.W.G." If the dealer issued no such list, then, *caveat emtor*, the comparative lightness of the S.W.G., if enforced by the judge, would be against the purchaser. Surely the gauge was not so arranged to encourage the buyers to use it?

If we put decimals of the imperial inch and the possible results of litigation on one side, there is little to choose between one gauge and another, whether geometrical or arbitrary. The question becomes reduced to one of convenience. Every dyname maker but the humblest must keep a ton or two of wire in stock, and finding that his favourite dealers do not stock S.W.G. sizes, he naturally tries to work in with B.W.G., that his orders may be executed promptly. The dealer on the other hand, finding that few, if any of his customers ask for S.W.G., has no reason to push it, and under the circumstances it is not easy to see why either party should trouble themselves to be the first to make the move.

LIGHTING POWER OF ARC LAMPS.

In Berlin the civic authorities, in specifying their requirements in respect of the electric light, stipulated that the arc lamps to be supplied in "Unter den Linden" should be run with a current of 12 amperes, and give a light of 2,000, or, in some cases, of 5,000 candles. Herr Elston considerably startled all parties interested, and gave rise to an animated discussion, by affirming that the actual lamps did not, in point of fact, give light exceeding 500 candles, and that this materially affected the price of light produced by electricity. The Allgemeine Elektricitäts Gesellschaft of Berlin instituted a series of experiments in the electro-technical laboratory of the High School of Berlin, under Prof. Slàby; and, on the results of these experiments, Dr. Wedding gave a lecture, which itself gave rise to a good deal of discussion. Dr. Wedding asks, after considering the recent development of the demand for intense light, What is the meaning of the expression, "a 2,000-candle arc lamp"; is it with or without a globe; is it at any given angle, or is it an average intensity?

The first difficulty in the research conducted in the High School was that which never fails to present itself, the imperfection of photometrical methods. Measurement of light in one direction is, with an arc lamp, not sufficient; the intensity varies according to the direction: and measurements must run through at least 90deg., from a horizontal direction to one vertically downwards; or, for a closed room, through 180deg., from vertically above to vertically below the lamp. The measurements hitherto made at various angles have been made with the aid of mirrors. Dr. Wedding's experiments were on one of the Unter den Linden lamps, a Siemens' differential. The current supplied, as regulated by the Allgemeine Elektricitäts Gesellschaft, was 14 to 15 amperes at 48 to 52 volts, produced by a Schuckert compound dynamo worked by the gas engine of the laboratory. The rooms were high, and the intensities in various directions were thus measured directly, without mirrors; the photometer used was Elster's modification of Bunsen's. The carbons very rarely burn evenly; then the two sides are not equally illuminated: by using two photometers, one on each side, the average intensity may be found and recorded. The unit adopted was the German candle, trimmed so as to burn with a flame 1·8 inch high; this nearly coincides with the English standard candle. The intermediate light chosen was produced by Albert gas burners; any difference of colour (one side of the photometer disc red, the other side blue) becoming, after some hundreds of observations, insignificant to the experienced eye.

The intensity in a horizontal direction was very small (without globe, average 196 candles); it rapidly increased till about 20deg. (about 1,150 candles), attaining a maximum (about 2,014 candles) at about 42deg., and then began to sink rapidly; at about 60deg. there was no light, but shadow. The average intensity over the illuminated area was, without globes, about 1,228 candles. With globes, the photometric work was much more difficult than without them. With three given globes, the average intensities were:—

——	Horizontal.	Maximum.	Average intensity.
Globe I.	419	970	710
„ II.	519	1,093	777
„ III.	497	713	590

The horizontal light was thus absolutely greater with a globe. On the whole, the loss ranged from 40 to 53 per cent.; and this may be diminished, by the use of a reflector, to a loss of about 32 per cent. Tracing out, in the street lighting, the illumination of various points at a height somewhat less than that of a man's head, a series of curves was obtained which show that, with the average data given by the above measurements, and with the lamps at 26ft. 8in. above ground, the light necessary for reading (=10 candles at 40in.) is obtained for a distance of 53ft. from the lamps. The lamps are 137ft. apart. In the intervals the light sinks to 4½ candles at 40in.

Dr. Wedding thus finds the actual lighting power of the Siemens differential arc lamp, as used in Berlin, with the globe on, to range from 510 candles directly downwards to 1,183 in a downward direction inclined 40deg. to the horizon, and 640 at a downward slope of 5deg. Dr. Wedding had the lamps clean and bright in the laboratory. His broad result is that with the most transparent of the globes supplied him, and with freshly-whitened reflectors, the average lighting power was 834 candles. Herr Elster, in actual street measurements, obtained an ultimate average of 641 candles; his earlier results were below this, being about 500 candles.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

MONDAY, November 11th.

LONDON CHAMBER OF COMMERCE.

4 p.m. Special Meeting of the Electrical Trades' Section.

TUESDAY, November 12th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Inaugural Address of Sir JOHN COODE, K.C.M.G., President, and Presentation of Medals, Premiums, and Prizes awarded at the end of last Session.

ROYAL VICTORIA HALL.

8:30 p.m. Lecture, "The Heart and How it Beats." By W. FURNEAUX.

WEDNESDAY, November 13th.

ROYAL MICROSCOPICAL SOCIETY.

8 p.m. Ordinary Meeting.

THURSDAY, November 14th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary Meeting. "On the Lighting of the Melbourne Centennial International Exhibition." By TH. L. MURRAY, Member.

FRIDAY, November 15th.

PHYSICAL SOCIETY.

5 p.m. "On Electrifications due to the Contact of Gases and Liquids." By J. ENRIGHT. "On the Effect of Repeated Heating and Cooling on the Electrical Resistance and Temperature Co efficient of Annealed Iron." By H. TOMLINSON, F.R.S. "Notes on Geometrical Optics." Part II. By Prof. S. P. THOMPSON, D.Sc.

INSTITUTION OF CIVIL ENGINEERS.

7:30 p.m. Students' Meeting. "The New Harbour and Breakwater at Boulogne-sur-Mer." By S. C. BAILEY, Stud. Inst.C.E.

Digitized by Google

The Electrician.

Published every Friday. Price Fourpence; Post Free, Fourpence Halfpenny.
Editorial, Publishing and Printing Offices:

No. 1, SALISBURY COURT, FLEET STREET, LONDON, E.C.

Telephone No. 2714. Telegrams: "ELECTRICIAN NEWSPAPER, LONDON."

All Communications to be addressed to "THE ELECTRICIAN," *1, Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN."

All letters intended for insertion in "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. Subscribers should receive their copies by the first post on Friday morning.*

"THE ELECTRICIAN" *is on sale at the railway bookstalls throughout the United Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices as above.*

SPECIAL NOTICE.

Owing to the increase in the number of pages of "THE ELECTRICIAN," in order to partly cover the increased postage, we have been compelled to revise the rates for Foreign Subscriptions, which are now as follows:—

	3 months.	6 months.	12 months
For Foreign Parts and Colonies:—	s. d.	s. d.	s. d.
Within Postal Union	6 6	12 6	24 0
Aden, Borneo, Ceylon, China, India, Japan, Java, Labuan, Mozambique, New Caledonia, Persia, Philippine Islands, Siam, Transvaal, and Zanzibar	7 6	14 6	28 0
The rates for the United Kingdom remain as follows:—	5 0	10 0	19 6

TO ADVERTISERS.

"THE ELECTRICIAN" *offers exceptional advantages to Advertisers.* **It has the largest circulation of any English Electrical paper, and circulates all over the World.**

Particulars relating to Advertisements will be promptly forwarded on application to the office.

TRADE ADVERTISEMENTS *intended for the current issue must be handed in not later than First Post on Thursday morning.*

SMALL PREPAID ADVERTISEMENTS *(for Rates see page xv.) are accepted up to 4:30 p.m. on Thursday.*

TECHNICAL PRINTING.

"THE ELECTRICIAN" PRINTING AND PUBLISHING COMPANY (LIMITED) *beg to inform Electricians, Electric Light Engineers, &c., that they make a specialty of Technical Printing, and have a Staff thoroughly acquainted with Electro-Technology. They can, therefore, promise Accuracy and Despatch in the Printing of Electrical Catalogues and Electro-Technical Literature generally.*

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.

Royal 8vo.

Early in each year is issued "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK. *The* DIRECTORY *was established in 1883, and the 1889 Edition, which is now on sale, consists of more than 600 pages of printed matter. Every care is taken to make the names and addresses of all persons engaged in the Electrical Industries absolutely accurate. Useful Tables and Electrical Formulæ are given, together with popularly-written Biographical Notices of the leading Electricians, Electrical Engineers, &c., accompanied in many cases by Portraits.*

The issue for 1890, which will be still further enlarged and improved, is in active preparation. New Names and Addresses, Corrections, Advertisements, &c., should be forwarded at once to the Publishing Office, 1, *Salisbury-court, Fleet-street, London, E.C.*

CONTENTS OF THE CURRENT NUMBER.

NOTES 1
A Comparison between the Continental, American, and English Dynamo-Electric Machinery. By Albion T. Snell. Illustrated. Continued 5
Sir William Thompson's Chain of Electrostatic Voltmeters. By Andrew W. Meikle, M.A. Illustrated 6
Wire Guages. By Alex. P. Trotter. Illustrated 8
Lighting Power of Arc Lamps... 9
Meetings of Scientific Societies... 9
THE INSTITUTION OF ELECTRICAL ENGINEERS 10
Dinner of the Institution of Electrical Engineers 12
Train Electric Lighting. By Charles Selden 15
Physical Society—
"On a New Electric Radiation Meter. Illustrated 16
"On a Method of Driving Tuning Forks Electrically." Illustrated 17
The Western and Brazilian Cable Company and the Brazilian Government 17
American Notes 18
CORRESPONDENCE—
Continental and English Generating Plant.—Willans and Robinson 19
The Use of Steel Bearers for Overhead Wires—"Practical Electrical Engineer" 20
The Institution of Electrical Engineers.—"Telegraphy". 20
The Employment of Chromic Acid instead of Nitric Acid in the Bunsen Cell—Charles Penruddocke 21
Ocean Cable Repairs.—Sir James Anderson..... 21
Overhead Wire Rules.—Alex. P. Trotter 21
LEGAL INTELLIGENCE—
An Injunction 21
United Telephone Co. *v.* Smith 21
COMPANIES' MEETINGS, &c.—
Brazilian Submarine Telegraph Company (Limited)... 21
The Western and Brazilian Telegraph Company (Ltd.).. 22
The West India and Panama Telegraph Company (Ltd.).. 22
Swan United Electric Light Co. 23
City Notes, &c. 23
Companies' Share List 23

SPECIAL NOTICE.

With this number of "THE ELECTRICIAN" is issued (gratis) the Index to Volume XXIII. Complaints of non-receipt should be promptly made to "The Publisher."

NOW READY.

Volume XXIII. of "THE ELECTRICIAN," price 12/6, post free, 13/6.

ALSO NOW READY.

Cases for binding Volume XXIII., price 2/0, post free, 2/3.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

THE INSTITUTION OF ELECTRICAL ENGINEERS has taken one more step in imitation of that older society on the lines of which it is worthily modelled, in inaugurating an annual dinner of its members. The first of these social conventions (the proceedings of which are fully reported in our columns) may be fairly looked upon as a successful innovation. The Anglo-Saxon race is characterised by its faculties for self-government and colonisation, and amongst its minor specific qualities may perhaps be included that of dining together in aid of, and celebration of, various events. Two years ago the members of the electrical fraternity met and dined in commemoration of the Jubilee of the Electric Telegraph. The present reunion may be considered to mark not so much the recollection of that which is past, as the recognition of present facts and future hopes. It was a happy selection which placed SIR WILLIAM THOMSON in the Presidential Chair during the first year of the existence of the Society under its new style and title. The change of name of the Society was something more than the change of a somewhat cumbersome denomination into a more brief and business-like name. It was a mark and indication of the fact that a change had come over the spirit of the dream, and that applied electricity could no longer be spoken of as comprising only telegraphy and telephony, but had grown up into a constructive science concerned with the manipulation of special forms of energy applied in many diverse but equally important ways to the satisfaction of the requirements of practical life. It was, moreover, an indication of the fact that the era had arrived at

Digitized by Google

which the practical applications of electricity had become sufficiently numerous to justify a title covering not one, but all of them, and which should at the same time emphasise the fact that the main objects of the Association were not the accumulation of fresh information, with possible future applications, but the practical applications in constructive work of that already existing to meet the wants and extend the powers of modern man. The SOCIETY OF TELEGRAPH ENGINEERS AND ELECTRICIANS therefore, after eighteen years of useful work, to metamorphosed itself into an INSTITUTION OF ELECTRICAL ENGINEERS, and it did certainly well in selecting as its leader, in the first year of its transformation, the present illustrious President, whose long range of scientific work has extended into the domain of practical and engineering construction with as much force and effect as it has into the region of mathematical and experimental physics.

The establishment of an Institution Dinner may be in one sense an affair of quite minor importance. What more natural than that the members of a definite profession, drawn every day into closer relations with one another, should desire to imitate the example of the other learned and professional societies who in the same way effect a social union of their members? On the other hand, there is an aspect of this event which is of much greater significance than the mere assembling round a table of a number of scientific men and their distinguished guests. It is the outward and visible sign of the fact that the electrical engineer has taken a definite position, and has a recognised existence in a way not consciously felt a little time ago. He is no longer one of a somewhat indiscriminate body, for the most part semi-practical, or engaged in occupations having a very problematical future, but he exists as a member of a particular branch of the great confraternity of engineers, requiring a particular and special training for his career, and having a work of immense importance, to which he devotes his trained constructive skill and invention. In a passage of his eloquent and suggestive speech LORD SALISBURY regrets that historians have marked out the history of the human race into periods defined so much by the rise and fall of dynasties rather than by the appearance and development of those great inventions which are really the determining forces at work in moulding the ideas and habits of the human race. Antiquarians speak generally of a stone age, a bronze age, and an iron age; but the invention of printing by separable type, the combination of a steam cylinder and separate boiler and condenser, and the discovery of the facts of electro-magnetism and electro-kinetics are more definite and more important epoch-making events in the history of the world. The fact that the mechanical and civil engineers have laid their hands on the electric current as a means of extending the facilities of modern life, and the fact that the knowledge of processes and materials has become sufficiently advanced for them to do so, is one of those steps forward in the extension of human powers which has now taken place and brought into existence the profession of the electrical engineer. Not, however, be it remarked, consisting in the acquirement of a little engineering information by a student of electrical book or laboratory lore, but by the assimilation by the mechanical and civil engineer of a competent knowledge of those facts concerning electricity which are capable of being brought within the scope of engineering work. Already the human race has felt the power of this combination of the engineer and the electrician. He has commenced his operations by practically diminishing the size of our planet a million-fold. "He has assembled mankind," as LORD SALISBURY says, "on one vast plane where they can see everything that is done and hear everything that is said, and judge of every policy which is pursued at the very moment when those events take place." There are now no foreign lands. Every place to which a wire, insulated in air or laid under sea, is conducted by the electrical engineer, is, for countless purposes, placed in immediate contact with its imperial centre. And not merely in mere simultaneous knowledge of events is this new power felt: the power of simultaneous action is even more tremendous in its results. The PRIME MINISTER raised the veil for one instant from off the mechanism of Government in touching upon that incessant and instantaneous exchange of opinion and decision between those individuals who hold the reins of power in Europe, and for whom the electric telegraph serves the double purpose not only of ascertaining facts or feelings, but of enabling them to put in simultaneous motion all parts of that immense machinery of offence and defence of which the armaments of Europe are the active parts. The electrical engineer has not only revolutionised the conditions under which the politician and statesman work, but has done the same for commercial life, as those know full well who have lived across the period before and after the existence of submarine cable enterprise. His scope of action seems almost unlimited in altering the conditions under which human beings work. If the invention and perfection of the steam engine has acted as a concentrative power upon human life, necessitating the aggregation of men and women in great cities and in huge factories, the electric engineer posseses the magic wand which can, perhaps, reverse in the future some part of this process, and bring the power to the worker rather than the worker to the power. This question of the distribution of power is one the mere fringe of which has only yet been touched. That which blocks the way at present, and to which the electrical engineer requires to direct his most fertile invention, is the perfection of underground conductor systems. The diffi ulties of this are by no means as yet completely overcome, and to the electrical engineer of the present falls the task of grappling with those real and existent difficulties which seem often non-existent in the minds of those who are more electricians than engineers. At the present moment the utilisation of electric energy for the production of light is the one most prominently before the public mind. All the large cities in Europe and America have made progress, more or less, in the completion of conductor system, which make possible the public distribution of electric current and the sale of electric power. The very conception of an electric central station is not much more than ten years old, and yet before the close of this century the electric engineer will have made it so familiar a fact that it will cease to excite the smallest surprise. Electric locomotion has passed—at least in America—out of the region of an interesting lecture-subject into the domain of commonplace realities, and there are not wanting indications that this department alone is one of undreamt-of possibilities of development. The Institution whose members represent the active agents in our own country in the production of these tremendous transformations of the conditions of society, is one whose existence is not only a necessity but a growing one. The exchange of experience, the collection of information, and the stimulation of thought brought about by the existence of a corporate union between the members of a scientific profession is valuable and essential, and the practically important and useful results which can be brought about by the wise and careful guidance of such an Institution receives increasing illustration. It will achieve this, however, just in proportion as it keeps in touch with the practical necessities of its practical members. A little too much soaring into regions of theoretical science, and occupation of time on matters which are outside

Digitized by Google

the range of actual electrical engineering, will result in reduced usefulness and power; but a ready and energetic action in dealing with all questions which affect this ever-increasing public use of electricity will tell inevitably in increasing the extension of electrical enterprise and its own utility. The INSTITUTION OF ELECTRICAL ENGINEERS has already been able, in the first year of its existance as such, to give effect to the consensus of feeling among its members on some important practical matters, and there is much that it may do in this way, whilst still preserving the status of a professional Society. In the collection and diffusion of information, it has a wide field of work open to it, and there is, perhaps, no more useful mode of performing work of this character than by the delivery from time to time of Lectures on special practical subjects by the most authoritative persons in their particular departments. We call to mind in this connection the entirely admirable Lectures of this kind arranged by the INSTITUTION OF CIVIL ENGINEERS in 1882, in which the leading men in particular branches of knowledge expounded some subject of highly practical interest. One thing which greatly aids in adding interest to Papers or Lectures is the experimental illustration of them. The Chemical Society have, we believe, a laboratory in connection with their meeting room, in which experimental illustration can be prepared. Ought we not to look forward to a time when the INSTITUTION OF ELECTRICAL ENGINEERS will have an electrical laboratory of their own, or at any rate the means of amply illustrating any of the Papers or Lectures read before them which require it or admit of it? These and all other details of development will arrive in time, and as they are needed. Sufficient for the present, that the Institution is, as the PREMIER remarked, "weaned," and that the recognition of the status and the work of the Electrical Engineer has been prominently thereby advanced. It will be maintained only, however, by the sober success of the undertakings guided by him. We have passed through the stage of excited public imagination, and a necessary corresponding reaction concerning the problems of public use of electricity, and are now freed from the restrictions which an immature legislation cast about the electrical industry. The field of operation lies widely open for all wise and skilful development of solid invention, and although there is an unlimited possibility of failure when work of an important nature is undertaken by ill-informed or ill-advised individuals, yet the way, at the same time, is prepared for conspicuous triumphs when capital and energy are directed by competent and cautious Electrical Engineers.

DINNER OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

The first annual dinner of the above Institution was held on Monday night at the Criterion Restaurant, under the presidency of Sir William Thomson, the guest of the evening being the Prime Minister. Amongst the other gentlemen present were the following:—Sir F. Abel, Sir James Anderson, Sir F. Bramwell, Sir J. Coode, Sir J. Kitson, Sir H. Mance, Major Marindin, R.E.; Sir R. Rawlinson, Sir D. Salomons, Mr. Justice Stirling, Sir G. G. Stokes, Mr. Courtenay Boyle, Prof. W. G. Adams, Mr. Albright, Mr. Alabaster, Mr. Andersen, Dr. W. Anderson, Mr. Andrews, Dr. Baur, Mr. Beaumont, Mr. Bidwell, Mr. Binswanger, Dr. Borns, Mr. Bottomley, Mr. Bright, Major Cardew, R.E.; Mr. Carpenter, Mr. Clark, Mr. Cockburn, Mr. Cousens, Staff-Com. Creak, R.N.; Mr. Crompton, Mr. Crowe, Mr. Down, Mr. Dowson, Mr. Drake, Mr. Erskine, Mr. Esson, Prof. Fleming, Dr. Fison, Prof. Forbes, Mr. Forrest, Prof. Foster, Mr. Garcke, Mr. Geipel, Mr. Gisbourne, Dr. Gladstone, Mr. Gordon, Mr. Gorham, Mr. Graves, Mr. Gray, Mr. Guy, Mr. Heaviside, Mr. Hedges, Mr. Higgins, Capt. Holden, R.A.; Mr. Holmes, Mr. Hookham, Dr. Hopkinson, Prof. Hughes, Mr. Kapp, Mr. Kempe, Mr. King, Mr. Laister, Mr. Manville, Mr. Massey, Mr. Mavor, Mr. Moulton, Mr. Muirhead, Major Flood Page, Mr. Pell, Prof. Perry, Mr. Phillips, Mr. Preece, Mr. N. Prentice, Mr. Price, Mr. Pritchett, Mr. Raworth, Mr. Rawson, Mr. Reckenzaun, Prof. Reinold, Capt. Sankey, R.E.; Mr. Schanschieff, Mr. A. F. Scott, Mr. Ronald Scott, Mr. Sennett, Mr. Sharp, Mr. Shoolbred, Mr. Siemens, Mr. Slater, Mr. A. T. Snell, Mr. Spagnoletti, Mr. Stroh, Mr. Swan, Mr. Swinton, Mr. Timmis, Mr. Truman, Mr. Varley, Mr. Von Buch, Mr. Wallace, Dr. Walmesley, Mr. F. H. Webb, Major-General Webber, Dr. Wedgewood, Capt. Wharton, R.N., Mr. Wharton,

The PRESIDENT, in proposing the health of Her Majesty the Queen, said that the Institution of Electrical Engineers had every reason to appreciate very highly the reign of Queen Victoria (cheers). During the lifetime of Her Gracious Majesty electricity had become a science. The earliest discoveries, one might say, took place very nearly at the time of Her Majesty's birth, and electricity became a branch of engineering almost at the very moment when Her Majesty came to the throne. The prosperity which had attended her reign, from the beginning of it down to the present time, had been shared by all those professions upon which the prosperity of the country depended, most notably those which had led up to the existence of the Institution of Electrical Engineers. The toast would, he knew, be received with loving loyalty on the part of all those present (cheers).

The PRESIDENT next proposed the health of the Prince and Princess of Wales and the rest of the Royal Family. They were, he said, a very kindly family, and one which was thoroughly appreciated and admired throughout the whole of the British Dominions. They always devoted themselves to doing their duty to those around them, and on every occasion they sacrificed their own inclinations to the public good (cheers).

The next toast proposed by the President was that of the "Army, Navy, and Reserve Forces," which was coupled with the names of General Webber, C.B., and Captain Wharton, R.N. Sir WILLIAM THOMSON said that it seemed as if the forces of the Army and Navy and Reserve were destined to become more and more electrical (hear, hear). By means of the telegraphists attached to the Royal Engineers the land forces had long been connected with electricity. Thirty years ago the first duty of an electrician was to make himself a sailor, because at that time the great part of electrical work consisted in the laying of submarine cables; but now electrical science was called into use in both branches of the service, and, in fact, formed the foundation of the scientific knowledge of the officers in those branches. At the present moment there were no less than 70 officers of Her Majesty's forces who were members of the institution, and, in fact, every midshipman, however good a cricketer he might be, however good in the boats, or in other branches of athletics, must now be an electrician, in order to carry out the various duties which he was called upon to perform (hear, hear).

Major-General WEBBER, in responding on behalf of the Army, said that of all the applications of electrical science there was none perhaps which interested him more than the electric telegraph as applied to the art of war. Nearly a quarter of a century had elapsed since he first saw the electric telegraph used in the campaign of 1866, in the results of which the art of telegraphy played so important a part, and when there was a line of telegraph extending from the Prussian army right through to Berlin. What would have happened, he asked, on that memorable afternoon of Waterloo if Blucher and Wellington had been in telegraphic communication? The advantages of having such a means of communication had been demonstrated in every small war during recent years in which the telegraphists of the Royal Engineers had played so important a part

Captain WHARTON, in responding for the Navy, referred to the great influence which electrical science had had in the development of the British Navy. Perhaps the most important point to mention was the use of electric search lights, without which no ironclad could guard against the attacks of torpedo boats. Sir William Thomson had done good service to the Navy, not only in regard to the laying of electric cables, but by his admirable compass, and the sounding apparatus, which were now so largely used on board ships (hear, hear).

Sir WILLIAM THOMSON (in proposing the next toast, that of "Her Majesty's Ministers") said: I have only to mention the name which I am about to couple with this toast to evoke those feelings which are so strongly felt by us in respect of what we owe to Her Majesty's Ministers. How is it that we can go on and live happily, and practice our professions and cultivate our sciences in peace? It is through the action of Her Majesty's Government. Good government produces happiness and prosperity to the whole nation, and incidentally to the scientific and engineering part of the nation, by enabling us to carry on our investigations and that great public work which is the object of the existence of such an Institution as the Institution of Electrical Engineers. Most of us think we have done our duty to the country when we have given our votes and paid our taxes, if we are taxpayers. But what a very small part is that as compared with the highest kind of work which is performed by those men whom the constituencies honour by electing them to be their members of Parliament! We owe all the happiness under which we live to those who do the work of the nation for us. Every member of the Government has some private occupation, which, as men of the highest

Digitized by Google

education and the highest ability everyone of them, they would wish to be doing, but which they have given up in order to perform their daily work as Ministers. And what must we, as electricians, think of the man who gives up electricity to serve in that way—a man who might be working in all the beauties of electrical science: following them, reading about them, investigating them, and making discoveries in them—were it not that a higher duty called upon him to take up the work of the State in the interests of the nation (cheers)? Gentlemen, as being one of ourselves in the sense of being a scientific electrician and an electrical engineer, I feel that we must all appreciate the honour which Lord Salisbury has done us in being present at this our first dinner at the end of the first year of the Institution of Electrical Engineers. Gentlemen, I ask you to drink to the health of Her Majesty's Ministers, coupled with the name of Lord Salisbury (great cheering).

The MARQUIS OF SALISBURY (who met with an enthusiastic reception) said: Sir William Thomson and gentlemen, I have to thank you on behalf of my colleagues and myself for the exceedingly hearty reception that you have given to the kind words in which Sir William Thomson has proposed this toast. I do not feel that I can accept the guise in which he has put my name forward. On the contrary, though recognising, as every individual must do, and as I have special reason to recognise, the enormous benefits which electrical science confers upon mankind, I feel that I have reason to apologise for my appearance in this assembly; and when I look around at the number of learned and distinguished men here present to-night, I feel rather in the position of a profane person who has got inside the Eleusinian mysteries (laughter). I have an excuse that the learned gentlemen, General Webber and Captain Wharton, who have replied on behalf of the Army and Navy, were able to show many particulars in which their special professional vocation was sustained and pushed forward by the discoveries of electric science, but I will venture to say that there is no department in the Government so profoundly indebted to the discoveries of those who have made this science as the Foreign Office, with which I have the honour to be connected (hear, hear). I may say that we positively exist by virtue of the electric telegraph. The whole work of all the Chanceries in Europe is now practically conducted by the light of that great science, which is not so old as the century in which we live. And there is a strange feeling that often you have communicated constantly and frequently day by day with men whose innermost thoughts you may know by the telegraph, but whose faces you have never seen (hear, hear). It is something more than a mere departmental effect which these great discoveries have had upon the governments of the world. I have often thought that if history were more philosophically written, instead of being divided according to the domination of the particular dynasties or the supremacy of particular races, it would be cut off into the compartments indicated by the influence of particular discoveries upon the destinies of mankind. Speaking only of these modern times, you would have an epoch marked by the discovery of gunpowder, an epoch marked by the discovery of the printing press, an epoch marked by the discovery of the steam-engine; and these discoveries have had an influence infinitely more powerful, not only upon the large collective destinies, but upon the daily life and experience of multitudes of human beings, than even the careers of the greatest conquerors, or the services of the greatest statesmen (cheers). In that list, which our ignorance of ancient history in its essential character forbids us to make as long as no doubt it might be made, the last competitor for notice, and not the least, would be the science of electricity. I think the historian of the future, when he looks back, will recognise that there has been a larger influence upon the destinies of mankind exercised by this strange and fascinating discovery than even by the discovery of the steam-engine itself—(hear, hear)—because it is a discovery which operates so immediately upon the moral and intellectual nature and action of mankind. The electric telegraph has achieved this great and paradoxical result: it has, as it were, assembled all mankind upon one great plane, where they can see everything that is done, and hear everything that is said, and judge of every policy that is pursued at the very moment those events take place. And you have by the action of the electric telegraph combined together almost at one moment, and acting at one moment upon the agencies which govern mankind, the opinions of the whole of the intelligent world with respect to everything that is passing at that time upon the face of the globe. It is a phenomenon to which nothing in the history of our planet up to this time presents anything equal or similar, and it is an effect and operation of which the intensity and power increase year by year. When you ask what is the effect of the electric telegraph upon the condition of mankind, I would ask you to think what is the most conspicuous feature in the politics of our time, that occupies the thoughts of every statesman, and that places the whole future of the civilised world in a condition of doubt and question? It is the existence of those gigantic armies held in leash by the various governments of the world, whose tremendous power may be a guarantee for the happiness of mankind and the maintenance of civilisation, but which on the other side hold in their hands powers of destruction which are almost equal to the task of levelling civilisation with the ground. And what gives those armies their power? What enables them to exist? By what power is it that one single will can control these vast millions of men, and direct their destructive energies at one moment upon one point? What is the condition of simultaneous direction and simultaneous action which alone gives to these vast armies their vast power? It is nothing else than the electric telegraph (hear, hear). And it is from that small discovery, worked out by a few distinguished men in their laboratories upon experiments of an apparently trivial character on matter, and with instruments not in the first instance of a very recondite description. It is on that discovery that the huge belligerent power of modern states which marks off our epoch of history from all that has gone before it, must be held by anyone who investigates into the causes of things absolutely to depend. I would venture to hope that this is not all in its great effect upon the history and government of our race that electricity may achieve. Whether it is so for good or evil in the main it must be for the future to determine. We only know that the effect, whatever it is, will be gigantic. But in the latter half of the short life of this hitherto young science another aspect of it has been developed, an aspect which I cannot help hoping may be connected with great benefits to the vast community of industrious and labouring men—I mean for the distribution of power, of which electricity has given such a splendid instance (hear, hear.) The event of the last century was the discovery of the steam-engine; but the nature of the steam-engine was such that the force which it produced could only act in its own immediate neighbourhood, and therefore those who were to utilise that force and translate it into practical work were compelled to gather round the steam-engine in vast factories, in great manufacturing towns, in great establishments where men were collected together in unnatural and often unwholesome aggregation. Now an agent has been discovered by which the force of the steam-engine, stiff, confined to its own centre, can be carried along far away from its original source to distances which are already great, and which science promises to make more considerable still (hear, hear). I do not despair of the result that this distribution of force may scatter those aggregations of humanity, which, I think, it is not one of the highest merits of the discovery of the steam engine to have produced (hear, hear). If ever it shall happen that in the house of the artisan you can turn on power as now you can turn on gas (and there is nothing in the essence of the problem, there is nothing in the facts of the science, as we know them, that shall prevent such a consummation from taking place)—that distribution of power should be so organised—you will then see men and women able to pursue in their own houses many industries which now require the aggregation of the factory. You may, above all, see women and children pursue those industries without that disruption of the family which is one of the most unhappy results of the present requirements of the industries; and if ever that result shall come from the discoveries of Oersted and Faraday, you may say that they have done more than merely add to the physical force of mankind. They have done much to sustain that unity, that integrity of the family, upon which rests the moral hopes of our race, and the strength of the community to which we belong (hear, hear).

Gentlemen, these are some of the thoughts which electricity suggests to one of my trade. Pardon me if I have wandred into what may seem to be speculative and unfamiliar fields. But, after all, the point of view from which we must admire the splendid additions to our knowledge which the scientific men of the world, and especially of England, during this century have made, is that they have enabled mankind to be more happy, to be more contented, and therefore to be more moral (prolonged cheering).

Sir FREDERICK ABEL, in proposing the toast of "The Learned Societies," said: We members of the Institution of Electrical Engineers do not aspire to count ourselves "learned," inasmuch as we do not, as a body, attempt to pursue science purely for its own sake; but I believe there exists no other body which so thoroughly and fully appreciates the work in this direction that is accomplished by the brethren of the learned societies. I feel sure that you will desire to associate with this toast of "The Learned Societies" the name of the man who, among scientific workers, has especially distinguished himself by his versatility of power, by his indomitable industry, by his encouragement of those who engage in the work of science for science sake, and by his always ready help to those who work for the application of science to practical purposes. I give you, my lord and gentlemen, 'The Learned Societies," and I couple with this toast the name of Sir Gabriel Stokes, the President of the Royal Society (cheers).

Sir GABRIEL STOKES, in responding, said: My Lord Salisbury and gentlemen, I rise to return you thanks for that toast with which Sir Frederick Abel has done me the honour of coupling my name. For a long time the Royal Society remained the only scientific society, and we took under consideration all branches of science. But as science grew, it was found expedient to establish special societies for special departments. Nevertheless, we look on those societies with a feeling of parental affection, and we retain so far our old constitution that we receive Papers on all subjects of science. When I came into the room and saw your programme of toasts I did not know to which of the two categories—to the learned societies or the professional societies—you considered yourselves to belong. If we look at the great achievements for supplying the needs of daily life which have been effected at the present day through the agency of electricity one would say that this Society belongs to the professional societies. In this very room we have an example of that beautiful electric light which has now become tolerably common, and of which, in all probability, before very long we shall see a good deal more in London. And then, again, I need not refer to the subjects which have been already so amply dwelt upon by Lord Salisbury and others—the total revolution which has been brought about by the introduction of the electric light. Nowadays the whole earth resembles, in a measure, one of our own bodies. The electric wires represent the nerves, and messages are conveyed from the most distant regions to the central place of government, just as in our bodies, where sensations are conveyed to the sensorium. And then, again, the orders are issued. Now, if these applications were alone considered, one would say that the Institution of Electrical Engineers is a professional society; but we must also look at the origin of the Society, and at the manner in which these remarkable results have been accomplished since the first discoveries. When I think of the applications of electricity, my mind cannot help going back to that laboratory in Albemarle-street, where the great Faraday made so many important discoveries which have borne fruit in those applications with which we are now so familiar; and to come to a more recent time, I cannot help remembering how deeply your President went into the mathematical theory of the electrical actions which take place in a submarine cable, and how the success of that first

Digitized by Google

great experiment of spanning the Atlantic was largely indebted to him for his investigations (hear, hear). Therefore, I cannot look on this Society simply as a professional society. I must consider that it forms the connecting link, being at the same time both scientific and professional (cheers).

Mr. LATIMER CLARK (in proposing the toast of "The Professional Societies,") said: My lord and gentlemen, I am entrusted with the toast of "The Professional Societies," and I shall have the pleasure of coupling with that toast the name of Sir John Coode. I have given due consideration to the question, and I say with all deliberation that a more important toast could not well be proposed. The members of the professional societies comprise among them a large proportion of the men who have really given to the world its present form and character. They comprise the various classes of engineers—the civil engineers, the mechanical engineers, and the electrical engineers; they comprise also the builders of ships and the men who have produced the great features of civilisation as we have it to-day. In doing this they have so changed the face of the world that we begin to feel almost already that it is getting a little inconveniently small for us; but at the same time they have added very greatly to the prosperity of this country—and of all countries, in fact; and they have added to the lustre of the reign of Queen Victoria. They have created a veritable epoch in the history of civilisation which will never be forgotten. And whatever may be the fate of this little island in all future time, however distant, this will be pointed to as the period of origin of some of the greatest inventions which have marked the progress of civilisation. Now, the members of the professional societies are not politicians, and have no political bias; but I think they have been a little unfairly treated by politicians. I have always felt that politicians, or at all events some of them, have claimed to themselves many of the merits and advantages which have really been earned for them by the professional societies and their members. They have for a long succession of years pushed forward in season and out of season the claim that to them have been owing the great bursts of prosperity which have from time to time marked the course of the last 30 years, so that it has at last come to be stated as a matter of creed, of belief, that all the great blessings that have been showered upon the world and upon society by professional men have been due to the action of these politicians (hear, hear), and that they have had a most profound influence upon the present condition of society and upon the present belief of those now living.

I am extremely pleased to find that this toast will be responded to by the President of the Institution of Civil Engineers, and I am sure you will be pleased as well, because it will give us an opportunity of testifying how much we appreciate the assistance we have always received from that Institution, and the kindness they have always shown to us. We have been permitted from the first to occupy their magnificent room and theatre, and really to disport ourselves there as if we were the proprietors (hear, hear). I hope they have never seen reason to regret it. I do hope that, whatever may be our fate, the friendly relations and cordial feelings which have existed up to the present time between these two sisters will be strengthened in the future so long as these convivial meetings last (hear hear). The toast I have to propose to you is, "The Success and Prosperity of the Professional Societies, accompanied with the name of the President of the Institution of Civil Engineers" (cheers).

Sir JOHN COODE (in responding) said: Sir William Thomson, my Lord Salisbury, and gentlemen, I think if I rightly interpret what fell from Sir Gabriel Stokes, he has a feeling, in common with myself, that the learned and the professional societies might very well have been coupled together; in fact, to separate them appears to me to be very much like separating man and wife, because the inter-dependence of the one upon the other is of the most intimate kind. I am pleased to find that the civil engineers did in the younger days of the Electrical Institution extend to them a helping hand when they were only just fairly out of their swaddling clothes (hear, hear). Well, we did that with the utmost pleasure, and we have only done to electrical engineers what we have done to other kindred societies. We have regarded ourselves—I hope I may say so without vanity—as the parent of the professional societies: certainly in the case of those of an engineering character; and, whatever their character may be, we shall always be pleased to act to other societies of an engineering kind in the same manner as we have done towards the Institution of Electrical Engineers (cheers).

The MARQUIS of SALISBURY (in proposing the toast of "The Institution of Electrical Engineers") said: Sir William Thomson and gentlemen—As your toastmaster has told you, the toast of the evening has been confided to my charge, though I feel that the lateness of the hour will prevent me from doing it that justice which it deserves. The toast is "The Institution of Electrical Engineers." This is no doubt a very interesting moment in the life of the Institution of Electrical Engineers. It is, I understand, their first convivial meeting; and an Institution which dines for the first time may be looked upon as a child that has just been weaned (laughter.) The simile is not so inapt, because it is just taking to its bottle (great laughter). All that I could say in its behalf would be pale compared to the consciousness of its merits which must inhabit the minds of all its authors, and they must feel that I should be profaning a sacred subject if I were to attempt to go into those technical details by which alone its merits could be sufficiently illustrated. But I feel that a paper which has been put into my hands will, at all events, illustrate what great need there was for an institution of this kind, and what splendid possibilities in the future its destiny discloses. I am told that this Institution contains nearly 1,700 members, although it is not a year old, and that it represents the science of electricity, its application to telegraphy—land and marine—to telephony, to electric lighting, to transmission of power, locomotion by electric railways, tramways, and omnibuses. Now this vigorous infant is obviously the child of the Institution, represented by Sir John Coode, who has just sat down. He may look upon himself, when I read this paper, as the possible grandfather of a tremendous offspring (laughter and cheers), for it is evident that this Institution will not remain barren. It will increase by what I believe physicists call gemmation, and there will be cut off from it from time to time new institutions, representing each one of the copious subjects which I have read to you. There is evidently, therefore, a great destiny for it in the future; but I think that those who have founded it have been wise not to commence their process of sub-division too soon. It is very well that these various kindred societies should remain together for some time longer, and that the cordiality which distinguishes the learned societies should be encouraged in the future by the close association and companionship of their early days. It is, indeed, a splendid sphere of activity which such a list as this points out for the science of electricity and for those who have to give it practical effect. It is a splendid career which it opens to all those to whom the maintenance and application of this science is confided (cheers). Whenever I have been—as I occasionally have the privilege of doing—in an assemblage of scientific men, I cannot help comparing, with a melancholy feeling, the endurance and permanence, and almost eternal existence, of the work with the transitory work of the profession to which I belong. Politicians may do good, or they may do harm; they hardly know what result destiny will give to their actions; they do not know how the Divinity will shape their ends which they are trying to rough-hew. They cannot so measure the causes which act on the formation of human events and human history as to judge of the permanence or transcience of their work. With you it is otherwise. Every brick that you add to this great pile will last as long as human consciousness endures. Every atom which an electrician brings to the great science which he cultivates will remain there doing its work right to the end, as long as the intellect of man exists by which the science can be applied. It is therefore a great destiny which your Institution has before it, and a great responsibility which lies upon it.

In asking you to drink to the good fortune and good health of this Institution, I will ask you also to couple with it the name of one who, more than any other living man, has given to electricity its power and its fame (loud cheers). In asking you to drink to it in conjunction with the name of Sir William Thomson, I add the name of one whose marvellous investigations, whose extraordinary inventions and singular accuracy, and the practical character of whose science has been felt by every man present, in whatever department of science he may be, in the practical carrying out of his work (hear, hear). If Faraday and Wheatstone have begun this work, the historian will record that no stronger hand ever existed to carry on the sacred flame to further generations than the hand of the distinguished and gifted man who has been your President this evening. I propose to you the toast of "The Institution of Electrical Engineers," coupled with the name of Sir William Thomson (loud cheering).

Sir WILLIAM THOMSON (who, on rising to respond, was received with loud and continued cheering) said: My Lord Salisbury and gentlemen—After the noble words in which we have just heard the domain of the Institution of Electrical Engineers described, I feel that, as the spokesman for that Institution, my voice is almost speechless, and no words from me will be worthy of the occasion.

As President of the Institution of Electrical Engineers, I must say at this its first convivial meeting, that its existence is owing to a marvellous succession of scientific discoveries, followed speedily by the reduction of those discoveries into practical form for the good of mankind. In having the honour of proposing the health of Her Majesty the Queen at an earlier part of our proceedings this evening, I did feel that the reign of Queen Victoria and the history of electricity as a branch of an applied science were synchronous, and synchronous to a most unique degree. The science of electricity is as old as human learning. In the remotest times Greek and Arabian philosophers give us something of our present electrical knowledge. Last century was full of work in pure electrical science, much of which we are going back to now we are finding out things which go to the very depths and subtleties of electrical science. But what is the most remarkable in the history of the subject is the tremendous development that it has received since the year 1819. The idea of the possibility of the conjunction of the words "electrical" and "engineering" did not exist, I think I may say, before the year 1837, when the electric telegraph came into existence. I do not say that the telegraph was invented by Wheatstone, but I do say that by the labours of Wheatstone and Cooke the electric telegraph became a practical servant for the use of man. Though the term electrical-engineering might have been in existence then, it was many years before it came into general use.

One very remarkable piece of work that we are likely to think of, especially in these last weeks of this year, during which we deplore the loss of one of the greatest workers in electrical science and its practical application that the world has ever seen, is the work of Joule. The great scientific discoveries of Faraday, which were prepared, almost, you might say, in his laboratory by their author for the purpose of allowing others to turn them to account for the good of man, had been going on for about fifteen years, when a young man took up the subject with a profound and penetrating genius most rare in any branch of human study, and perceived relations with mechanical power which had never been suspected—not even suspected by Faraday, although Faraday in our country, and Henry in America, had given all the principles upon which these applications depended. Joule saw the direct relation between electricity and force, and it is most remarkable for us to think that his was the very first determination of the mechanical equivalent with an electrical measurement (hear, hear). Joule's communication to the British Association when it met in Cork in the year, if I remember rightly, 1841, pointed out for the first time the distinct mechanical relation between electrical phenomena and mechanical. Joule was not a mere visionary who saw something in the air and admired it, threw a halo around it and left, but he pursued it to the

Digitized by Google

utmost practical point of work; and he it was who determined the mechanical equivalent of heat, and who explained what are known as magneto-electric effects at that never-to-be-forgotten meeting of the British Association in Ireland. His next determination was a mechanical one; his third one a mechanical one still; and his determination, though slightly altering the principle, thoroughly determined the results of his previous work, both in electricity and mechanical action, and led to that new development of thermo-dynamics which will be looked back upon in future centuries as the crowning scientific work of the nineteenth century. I do not say that it is all due to Joule; but I say that Joule's dogged resolution to go on till he had determined it, and his resulting determination of the mechanical equivalent, is one of a peak of mountains which will be looked back upon and admired more the further we are from it as one of the greatest scientific movements of the present century. For the Institution of Electrical Engineers, it is most interesting to think that one of our most important fundamental electrical elements, the purely electrical determination of the units of resistance—the British Association unit—should be called at the suggestion of one who is here with us to-night (Mr. Latimer Clark), and his colleague (Sir Charles Bright), whom we have lost many years ago, first of all the "ohmad," and soon after the "ohm." Now it is most remarkable to find that while that was determined electrically in the first place by a Committee of the British Association, by a purely mechanical method, a determination amounting to $1\frac{6}{10}$ths per cent. was first discovered, although not thoroughly recognised as being discovered, by Joule's mechanical measurement. It was Joule's mechanical measurement that first corrected the British Association unit and gave the true ohm. The true ohm was also ascertained by a second electrical measurement, chiefly by the measurement of Lord Rayleigh. Though many other measurements give nearly the same result, Lord Rayleigh's measurement gave that which we know to be the most accurate result; and it is wonderful to think that that agreed with the most minute accuracy with the purely mechanical determination of Joule. I think that at this, the first dinner of the Institution of Electrical Engineers, it is well that we should consider the memory of Joule as one of the most fundamental memories in the eventful history of electrical science, from the time when electricity was a science not devoted to mechanical purposes to the present time, when it has developed into being a branch of engineering (hear, hear).

Now this Institution of Electrical Engineers, which is nearly at the end of its first year, and which is now having its first annual dinner, I hope may go on and attract the sympathy of the world and place itself in harmony with the dining, if not with the scientific world in general. This Institution does not come into existence like Minerva, complete in its panoply, and standing forth before the world grand and beautiful as you see it to-day. It began with an Institution of Telegraph Engineers in 1870, 19 years ago. I should not like to be obliged to undergo an examination on the history it has had during those 19 years; but it was growing up, and destined by Providence to become the greater Institution of Electrical Engineers that we have to-day.

Now having said this, I need scarcely say that I feel profoundly thankful. At the same time, I cannot help a certain feeling of pride at being allowed to be President of the Institution of Electrical Engineers on this occasion. I thank you for the great honour you have done me in choosing me as your first President, and for the kind manner in which you have received my name and connection with the toast which Lord Salisbury has just put before you this evening (great cheering).

TRAIN ELECTRIC LIGHTING.*

BY CHARLES SELDEN.

Some months since your committee on Papers to be read at this meeting assigned to me the subject of "Train Electric Lighting," since which time I have been availing myself of every opportunity when coming into contact either with systems in use, or parties exploiting them, to glean all the information possible.

Whenever I attempted to get down to figures with any of these exploiters or promoters, I was always met with a general answer, which was of no use whatever to us who contemplated the introduction of such a system upon our roads. By travelling first, and carefully noting the devices employed, and then conferring with manufacturers, I became conversant with what ordinarily would be the cost of such things as were in sight, and I am now able to offer you, for probably the first time that it has been done, the *maximum figures* upon at least one system. This is the system employed by the Pullman Company, and which I will designate below as System No. 1, and from this we can deduce the cost of one other (System No. 2). I made several trips on their trains and observed the working of this system in all its particulars, spending the better part of three nights' run in watching, both in the baggage car as well as others, and it was very satisfactory indeed, the light being brilliant and everything that could be desired. I have examined the Boston and Albany system partially, but as that is purely a storage battery affair, I cannot report results in figures until facts are obtainable upon which I can stand and feel assured that the figures which I give will at least not represent a cost less than we would find if put into practice; the figures I herewith give you are therefore *maximum*. In practice this subject can well be considered under the head of three systems:—1. Lighting cars by the joint use of dynamo and storage battery; 2. Lighting cars by means of direct current from the dynamo; 3. Lighting cars by means of a charged storage battery. System No. 1 is in use by the Pullman Palace Car Company upon its limited New York and Chicago trains, the vestibuled trains of the Atchison, Topeka, and Santa Fé Railroad Company, and others.

Wiring.—The main wires or leads are covered in a moulding along the top of the car, and branches therefrom are either dropped down through the air tube of the ordinary lamp (where centre suspension is desired) or are led through the panel between the ventilators of the car, where it is desirable to have a bracket. On top of this moulding is placed another, and then all of this moulding is tinned over and securely soldered, so that there is no leakage into the car, and the wires are fully protected. They are also free, in a great measure, from any movement by reason of oscillation or jarring, and hence the chances for abrasion of the insulation are reduced to a minimum, while at the same time they can be got at much more easily than if they were placed between the roof and the head-lining. The average cost per car, fitted with the best wire, is about 100dols. This includes labour.

Engine and Dynamo.—A Brotherhood engine, directly connected with an Eickemeyer dynamo, both of them being upon the same cast-iron bed-plate, is placed within a lattice-work inclosure at the forward end of the baggage car, occupying a corner between the end door and the side door. Ordinarily this space is $3\frac{1}{2}$ft. by $5\frac{1}{2}$ft. This engine is fed by steam from the locomotive, the steam gauge within the baggage car usually showing a pressure of 60 pounds, of which 15 is exhausted through the pipe for heating the train. The dynamo has an electromotive force of 68 volts, and has 60 amperes at 800 revolutions per minute. It should be understood that at 900 revolutions the same machine would give you 80 volts and 80 amperes. A good dynamo of this capacity will give plenty of light for 120 lamps throughout the train, and is considered an economical one, for the reason that it has margin enough to serve a longer train than usually carried, so as to meet emergencies should they arise.

Storage Battery.—Each car carries in a box, securely fastened to the bottom of the car, 32 storage cells, and under the system of distribution this storage battery is partly in use at all times, furnishing, when the dynamo is running, 30 per cent. of the power given to the lamps, and, when the dynamo is not running, furnishing all the power. The weight complete of the battery and its boxes is 1,300lb. per car. During the day, or at other times, when the lights are not in use, the dynamo is run a number of hours charging these storage batteries, so that it is unnecessary to remove them from their location under the cars for a long term, dependent ordinarily upon whether or not they have been in a wreck, or by long use the plates have become buckled, when, of course, it is necessary to remove such plates and put the battery in good condition. It is claimed that with this system the storage batteries last longer than where they are subject to removal for recharging at the end of each trip.

This system, as in vogue, has an attendant costing 90dols. per month and board while on the train, who is more or less experienced in electric lighting; and at terminal stations—that is to say, Chicago and New York—an expert ordinarily inspects the condition of the electric service prior to the train leaving, and at the station at Pullman they have also an electric light plant, which is utilised for storing electricity for their cars placed in the shop and which are about to start out on the road.

The arrangement of the engine is so concise that I do not see why the baggage master should not be able to run it, after a little coaching, without any other attendant. For instance, if we have a gauge for steam from the engine with a notice under it that "This gauge should stand at 65," and under the ammeter, "This gauge should stand at 63," and under the tachometer, "This gauge should stand at 800," it seems to me that any one with the least bit of common sense and a little bit of drilling, would surely be able to run the plant, for (as can be explained to him) if with cock fully open steam should get below the point which you mark and call his attention to, he is to call on the enginemen for more steam. If the revolutions fall below 800 it would at once call his attention to the steam gauge, and if the voltmeter or the ammeter should show out of proportion, the test lamp in the baggage car or the other lamps in the baggage car would become dim, thus calling his attention, even though he were otherwise engaged. If the enginemen cannot give him more steam, then there is but one thing for him to do, namely, cut off the dynamo entirely and fall back upon the storage battery for the light for the train. This, I think, would complete all I have to say at present upon System No. 1, the expense of which I show in full later on in this Paper.

The system of lighting direct from a dynamo upon a train, without the auxiliary help of a storage battery (System No. 2), is not in use; but I confess that I do not see why it would not be a good thing to do and save the expense, both in plant and the depreciation of the storage battery. There is an objection, of course, that

* Abstract of Paper read before the eighth annual meeting at Washington, D.C., of the Association of Railway Telegraph Superintendents.

Digitized by Google

in case of any failure, either in connections, engine, or dynamo, the lights would go out, leaving the train in darkness. This, however, could be obviated, I think, by keeping one coach candle or one lamp in each car lit; it is necessary to carry lamps or candles anyhow for emergencies.

System No. 3 is employed by the Pennsylvania Railroad Company, the Boston and Albany, and some others. I have been unable as yet to get any figures as to the cost. This system consists in merely placing upon each car a number of cells of storage battery (the cost of each cell ranging from $9 to $12), which are usually charged at the terminal points, the batteries then being trucked to the cars and placed therein, running one trip and then being trucked out for recharge. The Pennsylvania Company use a small number of cells (12 to the car) and a low voltage lamp, namely, 23 volts. They claim to get 16 candle-power to each lamp, but I hardly think that they do this. The lamps that I have seen seem to me to be of less candle-power, and they seem to use a smaller number than are necessary to properly light the car for reading. Ordinarily they carry seven lights in the body of the car at 23 volts, one in the smoking-room of 22, and one in each hallway or approach of 24 volts, making in all 10 lights to the car. With the Pennsylvania Company, at the time of my examinations, these lights were employed only in their parlour cars. The best report I could get from that Company was to the effect that they really do not know what the lights cost them, that it had never been figured down in a fine way. They have power and electric light stations at Jersey City, and they use a portion of that power for storing current during the daytime, while at the same time the same power was employed at night in lighting their yards, &c., so that it was a hard matter to get at; but they had determined that, while the light was a little more expensive than oil, at the same time it was cheaper than gas as used by them formerly, which was placed in retorts underneath the car.

Referring to the figures that follow, the prices of engines and dynamos can be "shaded," while the depreciation noted may in some instances be greater than is shown, or in others less. Of course the figures given do not include the cost of steam which runs the engine in the baggage car; but on that subject it was reported to me as follows:—The officer of the Pennsylvania Railroad Company, who has such matters in charge, states that the difference in the consumption of coal upon their locomotives (and this, of course, is the proper source from which 1 figure) is so slight as between those that are feeding dynamo engines and those that are not doing so, as to make no difference practically, and it has not affected the premiums which are given to firemen upon their saving of coal. I find a difference in the opinion of the enginemen upon these trains, some saying that they do not notice, particularly, the loss of steam used by the dynamo engine, or in heating the train; others again complain that they always feel it.

Following is the cost per sleeping and dining car equipped with System No. 1, having Eickemeyer dynamo and Brotherhood engine, including depreciation and interest on plant at 5 per cent., *not* including salary of attendant.

SLEEPER.

Articles required.	No.	Cost each.	Total.	Depreciation per cent.	Total.	Interest at 5 %.
Battery cells ...	32	$9.00	$288.00	16½	$47.52	$14.40
Wiring.....	1	100.00	100.00	.....	.....	5.00
Lamps.....	26	.75	19.50	700	135.50	6.83
Lamp-sockets...	26	1.10	28.60	1	.29	1.43
Cut-outs	1	.45	.45	.....	.02	.20
Switches	1	4.00	4.00	.....	.....	.20
Connections ...	1	20.00	20.00	.....	.....	1.00
Shade-holders...	26	.16	4.68	.....	.....	.23
Shades.....	26	.35	9.10	10	.91	.46
Elec. light arms.	26	1.15	29.90	.....	.....	1.50
Total	...	.....	$504.23	.....	$185.22	$31.07

DINING CAR.

Articles required.	No.	Cost each.	Total.	Depreciation.	Total.	Interest at 5 %.
Battery cells ...	32	$9.00	$288.00	16½	$47.52	$14.40
Wiring	1	100.00	100.00	.. ...	.....	5.00
Lamps	21	.75	15.75	700	110.25	5.52
Lamp sockets ...	21	1.10	23.10	1	.23	1.16
Cut-outs	1	.45	.45	.....	.....	.02
Switches	1	4.00	4.00	.....	.....	.20
Connections.....	1	20.00	20.00	.....	.....	1.00
Shade-holders ...	21	.18	3.76	.....	.....	.19
Shades	21	.35	7.35	10	.74	.37
Elec. light arms.	21	1.15	24.15	.....	.....	1.21
Total	...	.....	$486.58	.....	$158.74	$29.07

Upon the above basis a train would cost for 365 days of ten hours each on System No. 1, as follows:—

Car.	Lamps.	Depreciation.	Interest.
Baggage	5	$156.03	$93.19
Smoker (or day)	14	121.66	26.26
Day.....	14	121.66	26.26
Sleeper	26	185.22	31.07
Sleeper	26	185.22	31.07
Total	85	$769.79	$207.85

Or total as to equipment	$977.64
Add attendant at $90 per month	1,080.00
Total	$2,057.64
Or per day	$5.640
Per lamp, per day	.066
Per lamp, per hour	.006
Or for a baggage car, per day	.330
For a day car, per day	.920
For a sleeper, per day	1.720

System No. 2 would be as much cheaper than System No. 1 as the cost of battery and its depreciation would amount to. Either System, 1 or 2, without an attendant becomes still cheaper.

THE PHYSICAL SOCIETY.

At the meeting of this Society, held on the 1st inst., Mr. W. G. Gregory read a Paper

"On a New Electric Radiation Meter."

The author observed that the usual method of detecting the radiations emitted by an electrical oscillation consists in observing the sparks produced across a small air-gap in a wire, either straight or bent into a circle. Quantitative measurements made in this manner must necessarily be extremely rough, the method of measurement consisting in observing the width of the air-gap, which is capable of adjustment by means of a micrometer screw.

Mr. Gregory's method consists in observing the elongation in a stretched wire, due to the rise in temperature produced by the currents induced in it by the rapidly varying field of force.

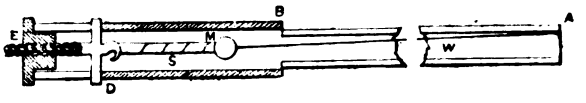


FIG. 1

The instrument, as shown in the diagram Fig. 1, consists of a long glass tube, A B, joined to a shorter piece of brass tubing, B D. Within is stretched a platinum wire, W, fastened to the glass tube at A, and to an Ayrton and Perry magnifying spring at M, at which point a mirror is attached in order to register the rotation by the reflection of a beam of light on to a scale. At E there is a screw for adjusting the tension. The brass tube is filed away in front of the mirror, so as to form a window, which is covered by a piece of plate glass. The object of the metal tube is to compensate the spring for general changes of temperature, and the glass serves the same purpose for the platinum wire.

The wire employed by the author was ·0086 cm. in diameter and 192 cm. in length. The spring, which had a length of about 25 cm., was made out of a narrow strip of very thin tinsel, by rolling it into a helical form, and then pulling it out in such a manner that it was free to untwist. This was effected by attaching the free end of the spring to a fine silk thread. It was then rolled between two hard surfaces, and again pulled out; and this process was repeated until at last it gave 10 complete rotations for an extension of one millimetre.

The mirror was a worked concave one, two-tenths of an inch in diameter, and gave a very good image of a wire on a scale at a distance of one metre. With an ordinary galvanometer scale there was no difficulty in reading with accuracy to a single division, which would correspond to an extension of ·000005 millimetres. The rise of temperature corresponding to this would be about ·003 of a degree centigrade. When the oscillator was at a distance of four metres a deflection of only one division was obtained, showing that the effect to be measured is an exceedingly small one.

The oscillator employed consisted of a pair of brass rods ·53 cm. in diameter, supported horizontally, and carrying zinc plates 40 sq. cm. in area, arranged to slide along the rods, so that the wave-length

Digitized by Google

could be altered at pleasure. The terminal knobs were 2 cm. in diameter, and the air-gap was about 2 or 3 mm. It was found that, during the experiments, one knob invariably became very hot, while the other remained cool, and it was the former which was the least blackened.

The induction coil used with the oscillator was 20 cm. long and 12 cm. in diameter, and it was worked by means of a tuning-fork contact-breaker, giving about 86 breaks a second. With the battery power employed, the coil gave continuous sparks about 4 cm. in length between its own terminals.

Increased sensitiveness was obtained by weighting the mirror so that its centre of gravity was behind, and slightly above the points of suspension, after which the tension was adjusted so that, when vertical, it was near a position of unstable equilibrium. A deflection of at least 10 divisions was then obtained with the oscillator at a distance of 4 metres; but the difficulty of using the instrument was greatly increased, since a small change of temperature, such as might arise from a slight draught, would alter the zero point very perceptibly. Theoretically, wires of some other material, *e.g.*, copper or aluminium, should give better results; but in the experiments made, the results obtained with them were less than before. Since everything depends on the tension in the wire being of exactly the right amount, the deflections might, however, the author thinks, be increased by employing very fine wires of copper or aluminium. The author considers that the possibility of compensating the platinum wire by means of a glass tube is an important point in favour of the method.

DISCUSSION.

In the discussion which followed,

Prof. PERRY inquired what would be the steady E.M.F. which, if it acted on the screw wire, would produce a similar effect. He suggested that copper ought to give better results than platinum, since, for a given E.M.F., the heating effect would be so much greater. He also suggested the use of a twisted strip, with a double twist, formed by taking a 2-mil copper wire, flattening it as much as possible, and then, after fixing it at the centre, twisting the ends about the axis of the strip, passing the fingers along the strip so as to have a uniform twist throughout the entire length. About one turn to an inch would be sufficient.

Mr. BOYS suggested that it was possible, though not very likely, that the elongation might be a direct effect of the current and not due to a rise of temperature, and he suggested that the point would be worth clearing up.

Prof. S. P. THOMPSON, with regard to this observation, asserted that Edmund's experiments had shown that there was no galvanic expansion in a wire traversed by an electric current, except that due to the heating effect.

Mr. GREGORY, in reply, said that he had made some tentative experiments with continuous E.M.F.s, but up to the present he had not obtained any very definite results. He had tried copper wire, but assuming the currents to be uniformly distributed through the thickness of the wire, aluminium ought to give results ten times as good.

Mr. GREGORY then read a Paper

"On a Method of Driving Tuning-Forks Electrically."

The author pointed out that in the ordinary method of driving tuning-forks by electricity, the battery circuit is completed just before the end of the stroke, and broken again soon after the commencement of the return motion, so that the fork receives the impulse at the most unfavourable moment, viz., when stationary. The impulse can be delayed to a considerable extent by including a solenoid in the battery circuit, and inserting into the solenoid an iron core, the distance to which it is inserted being determined by trial, so as to give the best effect. The driving, however, does not remain uniform. In the method devised by the author, the fork receives the impulse at the most favourable moment, viz., when it is moving with its greatest velocity.

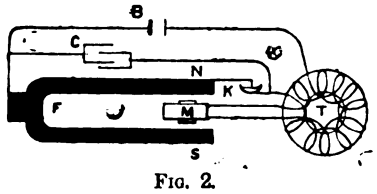


FIG. 2.

A tuning-fork, E (Fig. 2), mounted in the ordinary manner, is provided with the usual driving magnet, M, and mercury contact, K; but instead of taking the main battery current directly through the electro-magnet, M, it is sent through the primary coil of a kind of transformer, T, the secondary circuit of which is in connection with the electro-magnet, M.

The result of this arrangement is that the momentary induced currents, occurring both at making and breaking the main circuit, pass through the magnet alternately in opposite directions; and the fork being polarised, or converted into a horse-shoe magnet, the impulses are made to act as attractions and repulsions alternately, so that the fork receives two impulses instead of only one during each complete vibration. By properly adjusting the contact, so that it breaks the circuit at the moment when the fork is at rest, these impulses are given in the middle of the stroke.

The fork used in the author's experiments had prongs 20 cm. in length, and the distance between them was 1·8 cm. It made about 86 vibrations a second. The electro-magnet, M, was made by winding about 50 turns of No. 22 silk-covered copper wire round a core consisting of a bundle of varnished iron wires. It was mounted upon a wooden support maintained parallel to the prongs, and capable of sliding between them. The transformer, T, was composed of a core of cotton-covered iron bonnet wire, in the form of an anchor ring, with a mean diameter of about 6 cm., and a thickness of 1 cm. The secondary wire, consisting of about 160 turns of No. 22 silk-covered copper wire, was wound upon this, and the primary, consisting of about 190 turns of similar wire, was wound on over the secondary. In order to diminish sparking, a condenser of about 4 microfarads capacity was connected with the terminals of the mercury contact-breaker, K. A current of about 2 amperes, obtained from a small accumulator, B, was employed to work the apparatus. No attempt was made to use less battery power, but there can be no doubt that this could be done if the number of turns of wire were increased. There would probably, however, be a limit to this, as the lag would ultimately become so great as to interfere with the proper timing of the impulses.

The author then described an alternative method requiring far less battery power, but necessitating two contacts, as shown in Fig. 3.

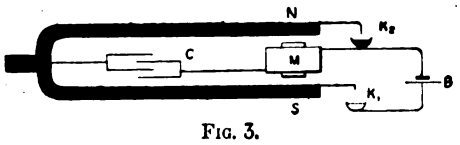


FIG. 3.

The condenser is charged through one contact, K_1, and discharged through the other, K_2. The currents, both charging and discharging, are taken through the electro-magnet, and the action is of the same kind as in the instrument previously described. The electro-magnet, M, must be wound with a large number of turns of fine wire, and a large condenser and powerful battery are required. The latter might, however, probably be replaced by a polarised battery of lead or platinum wires immersed in dilute sulphuric acid. Except with respect to economy of working, the second method is inferior to the former one, as the adjustment of the contacts, K_1 and K_2, would have to be made with great exactness. In case of objection being taken to the necessity of magnetising the fork, the author pointed out that forks driven electrically in the ordinary manner soon become magnetised; and, as a matter of fact, the fork first experimented with by the author had acquired its magnetism in this manner, and did not require any further magnetisation.

DISCUSSION.

In the discussion which followed the reading of the Paper,

Prof. S. P. THOMPSON observed that the device of introducing an induction coil was an extremely elegant one. If the method proved to be workable with a smaller current, the author would have supplied a great desideratum. In order to test the constancy of the vibration, he suggested the employment of a pair of forks of the same period, one of which could have a lens attached to one end, so as to determine the vibration period optically. He did not approve of a suggestion made by the author, that the phase of the E.M.F. might be retarded by the introduction of self-induction, for a contact taking place at the end of the throw would depend on the time occupied by the excursion. He did not believe that the author's second method would be a useful one, as, owing to mechanical drag, the contact would probably not occur exactly at the centre.

Prof. J. V. JONES suggested that the author's arrangement should be tested for constancy by taking simultaneous records from the fork and from a clock, a method which he himself had employed with success.

Mr. GREGORY, in reply, thanked Prof. Thompson for his suggestions, and maintained that the mercury cup contact could not be very far out as the fork was found to drive all right.

THE WESTERN AND BRAZILIAN CABLE COMPANY AND THE BRAZILIAN GOVERNMENT.

Mail advices from Rio, of October 7th, bring particulars of the refusal of the Government to permit the laying of a second cable along the coast from Rio de Janeiro to Pernambuco, once more illustrating the utter disregard of the Brazilian Government for commercial interests. The old cable having broken, the Western and Brazilian Company had a new cable made for the service, but the Government is represented to have refused to allow it to be put down because the Company had not submitted its contract with

Digitized by Google

the Brazilian Submarine Company for Government approval. The "Associacao Commercial" petitioned for the new cable to be laid in the interests of trade and commerce, but in vain. The *Rio News* states that during the long interruption between Rio and Bahia many merchants preferred to send their messages *viâ* Buenos Ayres, Valparaiso, and Galveston, rather than submit to the delays, annoyances, and extortions of the State telegraph service. The *News* argues that the licence to operate a cable implies the repair or substitution of the first line, or any improvement for the benefit of the service, otherwise the granting of a privilege for 90 years would be a farce. Our Rio contemporary hints that the real reason of the difficulty lies with subordinates whose object it is to divert the traffic on to the State lines. "For this reason," says the *Rio News*, "as well as for improved facilities in rapid telegraphic communication, we want another line along this coast which shall be under private control."

The fact is that after granting the concession to the Western Brazilian Telegraph Company, and permitting it to lay its cables, the Brazilian Government erected and worked competing land lines of their own down the coast, and gave as a reason for this hostility to that and the Brazilian Submarine lines the fact that the two Companies have a joint-purse agreement; although at the time this was concluded the Government were offered a liberal proportion of the joint revenue if they would bring the receipts from this land line into the arrangement. They, however, refused to do so, and as a measure of retaliation upon a Company with which they have entered into competition, notwithstanding that it works under their own concession, they simply obstruct progress.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *October* 26, 1889.

Overhead Wire Agitation in New York.—The question whether the wires shall go underground or shall stay overhead continues to be the leading one that agitates the New York papers and the mind of the New York public. As may be expected at such a time, any number of wild, irresponsible statements are being made by the press in their efforts to show how deadly a thing the electric wire may be, and the consequence is that the public is in a state of confusion worse confounded on the subject. Just what the outcome of the agitation will be nobody knows, and the local electric light companies, more particularly those engaged in lighting the streets, are in a state of desperation. At the present time there are no fewer than four official Boards indulging in a war dance over their unfortunate bodies, and each seems anxious to outdo the other in absurdity of propositions. What the Board of Electrical Control can do we are pretty well aware of by this time. This distinguished Board, which consists of a theatrical manager, a law clerk, and a retail butcher, has done its best to muddle and complicate the situation, and has frustrated well-nigh every effort that its energetic expert, Dr. Wheeler, has made to get things straightened out and in good shape. It is openly alleged that the Board is in close alliance with the Subway Company that has the contract for undergrounding the wires. Then the Department of Public Works has taken a hand in the matter, and by its activity in getting down the poles and wires has threatened to usurp the functions of the Board of Electrical Control, whose very supineness has been one of its saving recommendations as far as electricians are concerned. Next we have the Board of Health, which has been attempting to enforce some regulations insisting that continuous currents above 700 volts, and alternating currents above 250 volts, shall be prohibited. One of the evening papers distinguished itself by calling on this Board in a frantic manner to do something. Something was done, but the Corporation Counsel informed the Board that it had no authority in the matter; whereupon it and its enthusiastic coacher of the press incontinently subsided. The next body to take up the matter is the New York Board of Alderman, who now propose to conduct an investigation into the subject of overhead wires, and are already preparing to do so. Where a choice comes as to which of these bodies they would rather deal with, the local lighting companies feel that they are between the Devil and the deep sea, and their choice, if they have any choice left them, is only likely to add to their embarrassment and alarm. If there were any decent system of subways in existence, the companies would probably be more willing than they are now to go into them; but these subways are not satisfactory. The rate charged for a duct is no less than $800 a mile. The manholes are conspicuously small and inconvenient. The whole system keeps on filling up with gas and water, and explosions at the manholes are events of regular occurrence. It is the constant fear of being driven at any moment, such as the present, into these subways that has kept the local companies from putting their circuits into decent condition. As everybody knows, some of the old circuits are in extremely bad shape, as far as insulation is concerned, while the pole lines present a very ragged appearance. Since the accident to the lineman Feeks, nearly all the arc-lighting circuits on the streets have been shut down, and New York every night has been enveloped in a Stygian gloom. The streets have presented a most woeful appearance; the sandbagger has been on the alert, and robberies and assaults have been frequent. Yet the public have submitted to this, under the impression that it was necessary, and in some cases the panic has gone so far that people have refused to allow bell-wires to be run through their houses, under the impression that the touch of a push-button would bring them to the favourable consideration of the coroner. The whole business, in fact, is a sorry mess, and it is difficult to tell just what will be the next turn in the affairs. Probably we shall see considerable work done on the subways; but it is to be hoped that the new ones will be better than the old. Possibly it may be determined to bury only telephone and telegraph wires and low-tension circuits in general, at the same time adopting a system of carrying the high-tension wires far overhead where no other rotten wires can possibly come in contact with them, and where they will practically be as remote from the public as though they were at the bottom of the Hudson River.

Meeting of the American Street Railway Association of Minneapolis.—After the contemplation of New York at this time, and realising what grave effects throughout the country any hasty action here is likely to have, it is a positive relief to turn from electric lighting and look at the magnificent work that is being done in the development of electric railways. At the eighth annual meeting of the American Street Railway Association held at Minneapolis, the time and attention of the delegates was generally occupied with the consideration of electricity as a motive power. The President referred to it, the Executive Committee touched on it, and the report of the Special Committee on the subject was a striking vindication of all the claims that have been made as to the superiority of electricity for this purpose. The President in his opening address quoted the observation of a negro down South, who when he saw the electric car for the first time exclaimed exuberantly, "White man freed de darkey first, and now he freed de mule!" The Executive Committee said that during the last few years each succeeding year had seen electricity progress far more rapidly than any other motive power that had come to their notice, and they observed that this had been especially so in the organisation and operation of new roads. They considered it to be the duty of the managers of street railways to do all in their power to substitute some motive agency for animal, the inference being, of course, that they favoured electricity, it being the only available substitute for the horse on the vast majority of lines in this country. The report of the Special Committee on electricity, signed by Mr. Thomas C. Barr, chairman, is one of the most encouraging documents of the kind that I have seen for a long while. Mr. Barr gives a large variety of figures to show how electricity compares with other methods of operation, and adds:—"If it is desired to make a change from horse cars, electricity will fill the bill to perfection, no matter how long or short the road, or how many passengers are carried. In the investigation of the subject the most satisfactory results had been shown, and it not only increased traffic over the roads but reduced expense, and it enabled us to operate a line, which heretofore entailed a loss, at a profit." Mr. Barr also included in his report the operating expenses, gross earnings, and nett earnings of several roads employing electricity, and in each case the most remarkable development of capacity and profits was

Digitized by Google

shown. Mr. Barr also cited the reports made at Boston, where it appears that on the electric extension to Arlington, on the Cambridge division, there has been an increase of 150 per cent. in traffic, with 50 per cent. decrease in the operating expense, giving a nett gain of 200 per cent. The discussion on this interesting report elicited further significant figures from gentlemen running electric roads, and the whole session was one of the most remarkable triumphs of electrical application that could possibly be imagined. The development has been rapid up to this point, and the rate of increase will certainly be even faster after such a meeting as that. The Convention of the Western Electric Railway Association was also held during the same week in Minneapolis, for the purpose of discussing questions pertaining exclusively to electric railway operations, and the work of this body naturally went to strengthen and confirm the favourable impression that electricity made on everybody present.

Annual Convention of the Railway Telegraph Superintendents at Washington, D. C.—The Railway Telegraph Superintendents held their annual Convention a few days ago at Washington, D. C. At one time it looked as though the work of these officials would be necessarily limited in its scope, but of late years, owing to the adoption of various electrical appliances for different parts of the work on the roads, the duties of the telegraph superintendent have tended to become more and more onerous. A significant evidence of this condition was given in the fact that one of the most interesting and important papers presented was that by Mr. Charles Selden, the well-known superintendent of telegraph of the Baltimore and Ohio Railroad, on the subject of "Train Electric Lighting." Mr. Selden has given considerable attention to this work in its various details, and brought the result of his observations before the Association in an elaborate and careful statement. Mr. Selden, with all his predilection for electricity, did not consider that, so far, under the methods adopted, electric lighting had proved to be all that was claimed for it, the main fault being that involved in a high rate of expense. The chief difficulty that Mr. Selden had was to get bottom bed-rock figures on the subject. Thus, for example, with the Pennsylvania Railway Company, which is very careful in such matters, he was only able to ascertain that the company had determined that its system of changing the batteries on each run of the train was a little more expensive than oil, but, at the same time, was cheaper than the gas that they used formerly from reservoirs placed under the cars. Mr. Selden said that the system of lighting direct from a dynamo upon a train without the auxiliary help of a storage battery is not in use, but he did not see why it would not be a good thing to do, and save the expense both in plant and the depreciation of the storage battery. There was, of course, the objection that in case of any failure in connection—engines and dynamo—the lights would go out, leaving the train in darkness. This, he thought, however, could be obviated by keeping one candle and one lamp in each car, it being necessary to carry lamps and candles anyhow for emergencies. Mr. Selden gave, in addition, a very careful account of the method adopted by the Pullman Company, which runs a plant on board its vestibule trains, comprising an engine, a dynamo, and storage batteries, so that there is no need to remove the cells at any time; and hence, it is claimed, a longer life for them is secured. The expense of operating such a plant might be lessened, he thought, by placing it in charge of the baggage master, as he certainly ought to be able to attend to it. Some of his colleagues did not agree with him in this respect.

Electricity in Relation to the Human Body.—*Scribner's Magazine* will add next month to its interesting series of electrical articles one by Dr. Allen Starr, on "Electricity in Relation to the Human Body," in which the line is drawn very sharply between the legitimate use of electricity and the quackery which has undoubtedly built up not a few large fortunes at the expense of the public health. Dr. Starr states that he once demanded of the agent of a widely-advertised electrical belt some proof that an electrical current was produced by it, and he suggested that any such current could be detected by means of a galvanometer. This test was objected to; but a little frame, holding a dozen pocket compasses, was produced, and the power of the belt, which, doubtless, contained some iron plates to attract the needles of these compasses, was shown as truth of the assertion that the belt was a powerful generator of electricity. Probably many of those before whom this test was made were not able to distinguish between electricity and magnetism, and quietly gave up their ducats to the charlatan with whom they were dealing.

CORRESPONDENCE.

CONTINENTAL AND ENGLISH GENERATING PLANT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In Mr. Snell's interesting Paper on the dynamos at Paris, mention is made of the use in England of a frame-shaped bed, with the pole-pieces (of machines having the Edison type of field) sunk into the centre hollow, in which they are suspended by brass brackets. Machines of this type are stated to have been built by Messrs. L. Clark, Muirhead, and Co.; by Messrs. Crompton and Co., and by Messrs. Siemens and Co.; and in a footnote you instance the machines at Bradford and at Kensington Court as being of the description named. Mr. Snell also speaks of the system as "chiefly used for central-station work."

Perhaps you will allow us to point out that the construction referred to is that due to the use of Willans' Patent Combination Frame for engines and dynamos, and that not only the firms named but others are accustomed to make this type of machine for direct coupling to the Willans engine. It may also interest you to know that, besides the machines at Bradford and at Kensington Court, dynamos of this type (of course coupled direct to Mr. Willans' engines) are in use at, or are on order for, the following installations—viz., Liverpool, about 1,500 horse-power; Pall Mall (Mason's Yard), 2,200 horse-power; Gatti's Restaurant, &c. (with Edison-Hopkinson machines), about 550 horse-power; Savoy Theatre and Hotel, 650 horse-power; Whitehall Court station, 600 horse-power; Mr. D'Oyly Carte's new theatre, 400 horse-power; Leeds Fine Art Galleries, 300 horse-power; Post Office buildings, London (Elwell-Parker dynamos), 400 horse-power; and another installation in London (Goolden dynamos), 300 horse-power; while dynamos of the same pattern for minor installations on land have been coupled to Willans engines capable of developing over 3,000 horse-power, and for ship use to the extent of over 8,000 horse-power. It will therefore be seen that though the system is largely and increasingly adopted for central station work, it has been even more widely used in general installations, and on board ship. In central-station work the horse-power of Willans engines, coupled direct to dynamos mounted on bed-plates of the combination frame pattern, is, so far, less than that applied on bed-plates of other patterns. The balance is likely, however, to be on the other side before long.

The absence of this type of machine at Paris is probably due to the fact that, owing to our hands being so full of English work, and to the hindrance to business (now happily at an end) caused by the destruction of our works by fire last year, the Willans engine is little known as yet upon the Continent. The same reason may assist to explain the extremely low speeds of the large continental machines intended for direct-driving. They are simply made to suit engines which are incapable of running fast, and continental makers will see as clearly as English ones the advantage of using smaller machines and higher speeds, when they realise that an engine which is superior to their own elaborate and costly types in every respect of steam-economy, simplicity, cheapness, and durability, is also available for continuous running *at double speed*. For instance, the Willans central-valve engine of 200 horse-power (I. I. standard pattern, of which over fifty, coupled direct to dynamos, are now at work or under construction) has a standard speed of 375 revolutions—which is certainly double the speed at which any one would care to run a double-acting engine of like power; and even the engine of 550 horse-power (K. K. size) has a standard speed of 260 revolutions.

Digitized by Google

In any critique upon Continental electric generating plant as a whole, it appears to us that justice to the widely different system which obtains in England requires that attention should be directed to the enormous costliness of the foreign systems, both in space and in material—and doubtless in money. It is no exaggeration to say that any one of the electric generating buildings at Paris, with its enormous horizontal engines, and costly and noisy belts, and (in some cases) countershafting, might contain engines and dynamos on the English system, with an output at least five or six times as great (in some cases eight times as great), with a materially smaller steam consumption per electrical horse-power, and with probably little or no increase in the number of attendants or in the cost of maintenance. Unfortunately, the destruction of our works last winter prevented us from making any show of direct-driving engines at Paris, or the two systems might have been seen side by side.

Mr. Snell's remarks upon the unequal magnetic pull upon the armatures of single-limb-magnet two-pole machines are much to the point, and it is probable that in really large two-pole machines with the yoke below, the difficulties of working will be found very great, through the excessive pressure on the shaft and bearings, due to gravity and the magnetic pull combined. In large machines of the inverted horse-shoe pattern the pull does not produce merely a diminution in the weight of the armature on the bearings—it frequently overcomes it, so that the armature shaft revolves solely against the cap of the bearing; but by suitably boring the pole-pieces (not merely placing the armature out of centre) the pull can be lessened until it just fails to balance the weight, when the armature will, of course, run in its bearings almost without friction. Thus the difficulty which Mr. Snell refers to becomes an advantage. (It may be well to say that our experience is chiefly with machines having drum armatures).

We enclose a section of the Willans' combination frame applied to a dynamo absorbing rather over 200 indicated horse-power; the other end of the frame forms the lower part of the engine crank chamber. The width over all is about 4ft. 8in.; length of engine and dynamo, over all, not quite 14ft.; weight of engine, dynamo, and bedplate about 12¾ tons.—Yours, &c.,

For Willans and Robinson (Limited),
H. Farmer, Secretary.

Ferry Works, Thames Ditton, Surrey,
4th November, 1889.

THE USE OF STEEL BEARERS FOR OVERHEAD WIRES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I see by the paragraph relating to overhead wires, in your report of the meeting of the Electrical Trades Section of the London Chamber of Commerce, that the Council of the Institution of Electrical Engineers decided at present not to recommend any alteration of the Board of Trade rule referring to the use of steel bearer wires to carry the weight of copper leads.

As a practical electrical engineer, I should have thought that, although the use of bearers might be a necessity is cases of the long spans so usual in over-roof work, surely the disadvantages of increased strain to standards and additional resistance to wind pressure would not be so sufficiently compensated for by increased safety as to sanction their use in the case of very short spans.

In provincial towns where the electric light leads are supported on standards from 40 to 50 yards apart, I think, with due deference to the opinion of our learned Council, that the use of bearers is likely to be a questionable advantage.

I am glad to find that the Board of Trade are considering the plan of using silicium or other bronze wires.—Yours, &c.,

Practical Electrical Engineer.

November 6, 1889.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Some time ago I drew attention in your columns to the curious devolution which has taken place in the history of the society now known as "The Institution of Electrical Engineers." It began as the "Society of Telegraph Engineers," and in process of time, when it was full-blown and prosperous, it permitted the adoption of an outside branch of the same science, "the Electricians." In process of time the adopted bantling, like the growing cuckoo in the hedge-sparrow's nest, began to assert itself, demanding and obtaining due recognition, the society becoming "The Society of Telegraph Engineers and Electricians." In the great impetus given to electricity by the invention of the telephone and the development of the electric light, the bantling began to oust the parent-birds and their legitimate offspring, until to-day, to drop the simile, under a changed name, and with a management from which telegraphy (*qua* telegraphy) has been eliminated, the "Institution of Electrical Engineers" stands confessed as the society of all the branches of electricity—except telegraphy—for Mr. Preece and Mr. Graves are on the Council not in virtue of their telegraphic eminence, but because they are the representatives of the Government, and eminent in other branches of the science. Besides, it is no secret that they have withdrawn much of their active support from the Council under the new *régime*. To any one who knows the tone of a large majority of the Council towards our branch of the profession, and the contempt with which they speak of it as unworthy the attention of "scientists," this is not to be wondered at.

With such a history and such a tendency it was surely a cruel fate which made the first dinner of the reorganised society on Monday night the medium for the splendid eulogy of Submarine Telegraphy from the lips of the Prime Minister. Indeed, all the other speakers were compelled to follow Lord Salisbury's lead and add their tribute to the glorification of the despised branch which is not considered good enough to be represented on the Council. The noble Marquis might have stared himself blind before finding a single representative of the great Cable Corporations whose services to Britain and to the world he was celebrating, for the solitary cable magnate present, Sir James Anderson, was, in accordance with the policy of the Council, relegated to an obscure corner. Where were Sir John Pender, Lord Monck, the Marquis of Tweeddale, Henry Weaver, William Andrews, Sir Geo. Elliot, and other founders and directors of ocean telegraphy, who, by their enterprise, perseverance, capital, and untiring energy, have connected England with her Colonies and dependencies and with the other nations of the world? The Anglo-American, Direct United States, and the other Atlantic cables; the Eastern, Eastern Extension, and other lines connecting England with China, Japan, Australasia, India, and South Africa; the South American cables, and all the others whose 35 millions of capital and 120,000 miles of cable lie at the bottom of the sea were conspicuous in a very literal sense by the absence of any invited representative; there was only one gentleman there who could appropriate any share of Lord Salisbury's eulogy, or return thanks for his appreciation of the services rendered to successive Governments, and it does not appear that he was asked to do so.

Should anyone suggest that this remarkable absence was due to accident, and not to design, let him examine the list of Council, and say if there is a single manager or representative of cable telegraphy thereon. It may also be suggested that this argues a decline in telegraphy itself, but a careful study of the list of members and associates will show large numbers of telegraph, railway, and cable men. These (especially the cable men) are for the most part far from London, and having neither voice nor vote in the management of the society, have been unable to prevent the overthrow of their *confrères*. From the dissatisfaction which is felt at the course of events in the present society, I am convinced that the time has come when the telegraph men should withdraw and make a fresh start with a new Society of Telegraph Engineers, and from the Post Office, the railways, the manufacturing firms, the telephone and the cable companies a sufficient membership can be certainly counted upon to give the new venture an excellent start.—Yours, &c.,

Telegraphy.

Digitized by Google

THE EMPLOYMENT OF CHROMIC ACID INSTEAD OF NITRIC ACID IN THE BUNSEN CELL.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I venture to express my surprise that Mr. J. Wilson Swan should say that but small success has attended the endeavour to escape the necessity of employing nitric acid in battery cells, and that it was impossible to get the effect required without some nitric acid. Mr. Swan further adds that where a large current was required to be steadily maintained for several hours, the substitution of chromic for nitric acid proved to be wholly inefficient.

This is not my experience as a practical user for several years of chromic acid batteries. With the introduction of chromic acid, as made by Mr. Rowell's process, my batteries will run very constant for thirty or forty hours, giving a strong current. This has been fully proved by Mr. Rowell, who has tested them. I use no nitric acid in the cells. I am acquainted with the Holmes-Burke construction and the formula for charging; but I cannot see that Mr. Swan's plan of swaddling them up in sawdust, like a Norwegian kitchen, would tend to lessen the internal resistance of the cells, or improve them. At least, I do not see the advantage of it.—Yours, &c.,

November 5, 1889. CHARLES PENRUDDOCKE.

OCEAN CABLE REPAIRS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read in your issue of 1st instant an article on ocean cable repairs, extracted from the *New York World*, and think it right to correct some of the principal inaccuracies.

The writer states that icebergs pick up the loops of cable suspended between two submarine mountains, and carry them onward until the strain results in an absolute rupture. I have to state that there is no evidence of anything of the kind having ever happened.

Then the article speaks of one cable having been broken by a whale as a Munchausen story, and of another having been injured by a swordfish as a fairy tale; but I can say positively that both circumstances have occurred, only read *sawfish* instead of *swordfish*.

The account of picking up cables is, perhaps, sufficiently graphic and interesting for the general reader. I only wish, however, it was so easy to repair them as to be certain of accomplishing the work within three weeks, which is said by the writer to be the average time.

The extract also states that "Presumably the cost of laying a carpet bears the same relation to the cost of the cable as the *cost of carpet-laying does to the price paid for the carpet.*" This, if it were so, would indeed be satisfactory to cable companies; but, unfortunately, it does not in any way represent the facts of the case.

The last paragraph of the article is altogether misleading. I am sure the "Faraday" never attempted to pick up any of the cables laid by the "Great Eastern." Then it is stated that "the only thing the searchers (on the 'Faraday') had to guide them in their search was the log of the steamship 'Great Eastern,' which made known the course of the vessel certainly, but not with the extreme accuracy which was in such a case desirable." I may be allowed to state that the "Great Eastern," having lost the 1865 cable, steamed in 1866 direct to the spot where the cable was lost and recovered it, also that every mile of the "Great Eastern's" track on all her cable voyages was laid down with such accuracy as left nothing to be desired.

The whole of this paragraph is so very wide of the mark, not to say absurd, that it is evident the writer has never read the story of Atlantic telegraphy.—Yours, &c.,

JAMES ANDERSON.

Winchester House, 50, Old Broad-street,
London, E.C., November 4, 1889.

OVERHEAD WIRE RULES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The following is an extract from a letter from Major Cardew:—"I see there is a mistake in the report of the Chamber of Commerce. 'Low Pressure' has not been altered to 600 volts. But when the total potential difference cannot exceed 600 volts, and where the circuit can be earthed in the middle, and where the potential difference between any wires on the same poles or supports cannot exceed 300 volts, the wires are 'low pressure.'

"Instances:—A 5-wire battery system, 110 between each pair of wires, or a 10-arc circuit with a return wire led back by a different route."—Yours, &c., ALEX. P. TROTTER,

Correspondent of the Section.

LEGAL INTELLIGENCE.

An Injunction.

Mr. E. Ford on Thuraday last week applied to Mr. Justice Chitty, in the Chancery Division, on behalf of Mr. Monteith, of Leeds, for an interim injunction, with leave to serve notice of motion with copy of the writ in the action on the liquidator of an electric lighting company, to restrain him from removing from the plaintiff's premises the apparatus for lighting those premises with electricity. The circumstances under which the application was made were that in October, 1888, the company entered into a contract with Mr. Monteith to light his premises electrically for five years. The company since then had gone into liquidation, and a liquidator had been appointed. This gentleman, it was said, finding the contract an unprofitable one, had determined not to continue it, and he had given notice of his intention to remove the plant. The premises, not having sufficient gas-lighting power, it was alleged would be left in darkness if the electric lighting was discontinued, and on the ground that the contract of the company ought to be carried out, the plaintiff sought the relief of the Court, and Mr. Justice Chitty granted it.

United Telephone Company v. Smith.

This case came before Mr. Justice Chitty, in the High Court of Justice, on Saturday last, on motion for judgment in default of pleading by the defendant. The action was brought by the plaintiffs to restrain the infringement by the defendant of two of their patents. Counsel now asked for an injunction for delivering up of the instruments, an inquiry as to damages, and an order to pay the amount of such damages. The plaintiffs also asked for their full costs, charges and expenses, as between solicitor and client, up to and including the judgment, with liberty to apply as to future costs in chambers.

His Lordship made the order.

COMPANIES' MEETINGS & REPORTS.

Brazilian Submarine Telegraph Company (Limited).

The thirty-second ordinary general meeting of the shareholders of this Company was held at Winchester House, Old Broad-street, on Wednesday last. Sir James Anderson, in the absence of Viscount Monck, the Chairman, who was unable through indisposition to be present, presided.

The SECRETARY (Mr. Richard Collett) read the notice convening the meeting and the minutes of the last meeting, which were approved by the present meeting, and signed by the Chairman as correctly entered.

The report of the Directors was taken as read.

The CHAIRMAN said that the report presented, as usual, some of the phases incidental to telegraph companies. There had been ups and downs in the period under review. It would be found that they had lost £20,000 in their receipts compared with those of the previous half-year, though they had made nearly £4,000 more than they did in the corresponding period of the previous twelve months. That great reduction in their revenue was due mainly to interruptions in the Western and Brazilian line. He supposed they had seen by the newspapers the number of interruptions which that company had experienced, notwithstanding that they had left no stone unturned to get leave to duplicate their lines, and had had as many as three steamers on the spot for several months to effect repairs. He was glad to say that at present all the cables were working and their revenue was very good. Whether their friends would be allowed to duplicate their cable or not seemed to be a knotty question, but they said that they were using every endeavour to bring that about, and if the Brazilian Submarine Telegraph Company could possibly assist them in their efforts in that direction they would do so. At present there was some strong obstruction in Brazil which had not been overcome. That was the black side of the shield. The opposite side showed that the Company had a growing traffic and had £75,000 invested in the African Direct Line. Cables had been extended down to the Cape of Good Hope, and this Company had a joint-purse arrangement with those companies working down to that Coast, including the Eastern and South African Company. The revenue accrued in the current half-year from that source was £3,300, and Mr. Fuller, the Managing Director, estimated that the revenue that would accrue for the current 12 months from that cable, and from their proportion carried from St. Vincent to Lisbon, would be £14,000. So there were two sources of income, making up for some of those circumstances which adversely affected their earning power. He could congratulate them on receiving a very good dividend—the best that had ever been paid by the Company—while they would also find that they had a diminishing deben-

Digitized by Google

ture debt and a growing reserve. He would just like to say in this connection and "off his own bat," as it were—for it was his strong opinion—that there was nothing he liked better to see than a diminishing debt and a growing reserve. He thought that any one having an intimate knowledge of the effect of age, accidents, and possible opposition at all times, and the determination of different foreign Administrations, who had nothing to lose, to force companies down to lower tariffs, would be glad to see their reserve largely increasing. If he had his own way—that was to say, if the property were entirely his—he ventured to say that he would not credit himself with more than a 6 per cent. dividend at the very outside until he saw the reserve exceeding half a million and the debenture debt paid off. If any of the proprietors would be good enough to urge the adoption of that policy on the Board he thought they would take it into consideration very seriously at the next meeting. It was a matter for the shareholders, however, to determine. He concluded by moving the following resolution:

"*That the report of the Directors and the accounts to June 30, 1889, now submitted be approved and adopted, and that a dividend be now declared of 1s. per share (making, with the interim dividends already paid, a total dividend of 6 per cent. for the year ended June 30, 1889), and also a bonus of 3s. per share, in respect of the profits for the year ended June 30, 1889, the said dividend and bonus to be respectively free of income-tax.*"

The Hon. W. ST. JOHN F. BRODRICK, M.P., seconded the motion.

Mr. THEODORE CARTER was sure that the shareholders must agree with the Chairman, that the best thing they could do was to increase their reserve and diminish their debenture debt. There had been rumours of a fresh cable being laid to the River Plate. Might he ask whether there was any truth in those rumours, and in what way would an opposition cable, if laid, interfere with the present traffic of the Company?

The CHAIRMAN, in reply, said the Directors knew only what the shareholders themselves knew from what they read in the newspapers regarding a new cable. He did not know what its effect would be if laid. But if foreign Governments would continue to give subsidies to opposing companies it only remained for the Company to meet such opposition manfully. He was not sure that it would come about, but, at the same time, he was not aware of any means of preventing it if the Argentine Government thought proper to give a guarantee. The matter, however, had not come before them in a tangible shape so that they might grapple with it. But, as he held out to them in his remarks, they must look forward to things of that kind. There were always men of enterprise to be found, and if those men got foreign Governments to give them subsidies, the telegraph companies must be prepared for such contingencies. But he did not despair even if an opposition cable were laid, for they should even then be a dividend-paying Company. He did, however, like the policy of keeping the capital down as far as possible so as to pay a moderate dividend in adverse times, and of having a large reserve in order to keep the shares before the public as a valuable security, and he thought they were maintaining that position satisfactorily.

The resolution was unanimously adopted.

The CHAIRMAN next moved—

"*That the Right Honourable Viscount Monck, who now retires by rotation, be and is hereby re-elected a Director of the Company.*"

Sir HENRY D. GOOCH, Bart., seconded the motion, which was carried unanimously.

The CHAIRMAN next moved—

"*That the Duke de Loulé, who now retires by rotation, be and is hereby re-elected a Director of the Company.*"

Mr. THOMAS FULLER seconded the motion, which was also agreed to *nem. con.*

Mr. I. ANDERSON afterwards proposed—

"*That Mr. Henry Dever and Mr. John Gane be and they are hereby re-elected auditors to the Company for the ensuing year, with the remuneration of £50 each.*"

Mr. W. GRIFFITH seconded the motion, bearing warm testimony to the ability of the officers of the Company, and to the efficiency of the audit.

The resolution was cordially agreed to.

On the motion of Mr. GRIFFITH, seconded by Capt. BLAKEY, R.N., a cordial vote of thanks was passed to the Chairman and Directors.

The CHAIRMAN briefly acknowledged the vote, assuring the shareholders that their business had the constant and anxious care of the Board. The oppositions, to which reference had been made, did not spring up without giving the Directors occasion for much thought and frequent consultation. All that they could promise to do was to act steadily, daily, and always in the best interests of the shareholders.

The proceedings then terminated.

The Western and Brazilian Telegraph Company (Limited).

The following is the report of the Directors to be presented at the eighteenth ordinary general meeting, to be held at Winchester House, E.C., on Wednesday, the 13th inst., at 12 o'clock:—

The total earnings amount to £86,555. 17s. 10d., as against £86,874. 7s. 11d.—a decrease of £318. 10s. 1d. compared with the half-year to June 30, 1888.

The working expenses amount to £39,104. 15s. 5d., as against £32,813. 7s. 10d.—an increase of £6,291. 7s. 7d.

The increase is attributable to the higher exchange and to the purchase of extra instruments and appliances, also to additional staff and their travelling expenses, necessitated by the prevalence of yellow fever on the coast, and by increased traffic. The Board have much pleasure in stating that the conduct of the staff under trying circumstances was beyond praise. The ss. "Buccaneer" was chartered to take the place of the ss. "Norseman," which was ordered home for new boilers and repairs. The amount of cable used was also larger than usual during this half-year.

Including the amount brought forward from 1888 (£3,461. 17s. 3d.) and the dividend received upon the shares held in the "Platino" Company to June 30th, the balance to the credit of the revenue account is £58,237. 19s. 8d., from which has to be deducted £13,500 for debenture interest, leaving £44,737. 19s. 8d., of which £7,500 has been placed to the renewal fund, and £5,600 to the debenture redemption fund. This leaves £31,637. 19s. 8d. The Directors recommend the payment of a dividend on the ordinary shares for the half-year at the rate of £4 per cent. per annum (6s. per share), carrying forward £4,072. 9s. 8d. At the corresponding period last year the dividend was at the same rate.

Since the last half-year's report 545 "Platino" shares have been exchanged for 327 shares of this Company.

The dividend will be paid on November 15th.

The report also contains some interesting information in reference to communications which have been exchanged between the Company and the Government of Brazil relative to the proposed laying of loop or alternative cables.

The West India and Panama Telegraph Company (Limited).

The following is the report of the Directors of this Company for the half-year ended June 30th last, to be submitted to the twenty-fifth ordinary general meeting to be held at Winchester House, 50, Old Broad-street, E.C., on Wednesday, the 13th inst., at 2 p.m.:—

PATENT
SILICIUM BRONZE AND SILICIUM COPPER WIRE.
The best for overhead Telephone and Telegraph Lines,
AND ALL ELECTRICAL PURPOSES.
Hard Drawn High Conductivity Copper Wire.
ROLLED AND DRAWN
PHOSPHOR BRONZE.
PHOSPHOR BRONZE
BEARINGS, BUSHES,
AND OTHER PARTS OF
ELECTRICAL MACHINERY.
SOLE PROPRIETORS of the British, Indian and Colonial Patents,
THE PHOSPHOR BRONZE COMPANY (Limited),
87, Sumner Street, Southwark, London, S.E.
WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

Digitized by Google

1. The amount to credit of revenue is £49,985. 11s. 9d., and the expenses have been £24,458. 6s. 9d., leaving a balance of £25,527. 5s., which, with the balance of £1,154. 3s. 1d. brought from last account, makes a total of £26,681. 8s. 1d. Of this sum the Directors have placed £2,000 to reserve, leaving an available balance of £24,681. 8s. 1d., with which it is proposed to deal as follows :—

First Preference Shares—			
Balance of arrears of dividend, 6s. per share	£10,368	18	0
Dividend, six months to June 30th, 6s. per share..	10,368	18	0
Second Preference Shares—			
On account of arrears of dividend to June 30th, 10s. per share	2,334	10	0
Balance to current half-year's account	1,609	2	1
	£24,681	8	1

2. The traffic receipts for the six months show an increase of £672. 12s. 11d., as compared with the corresponding period.

3. The expenses for repairs to cables are £3,459. 9s. 7d. less than those for the corresponding half-year, owing to fewer interruptions. The Company's system is in good working order throughout.

4. The Company's ss. "Duchess of Marlborough" arrived in the Thames in May last, after an absence of four years; and having been surveyed and repaired, in accordance with Lloyd's requirements, returned to the West Indies with a supply of new cable for stock.

The Swan United Electric Light Company (Limited).

The following is the seventh annual report of the Directors of this Company, to be presented at the ordinary general meeting, to be held at the Cannon-street Hotel, London, E.C., on Thursday, the 14th inst., at two p.m. :—

1. The accounts accompanying the report are for the year ended September 30, 1889.

2. After paying all current charges, and making ample allowance for depreciation of plant, there is a credit balance of £21,042. 8s. 1d., to which must be added the credit balance of £10,052. 8s. 11d. brought forward from the last accounts, making a total of £31,094. 17s. The Directors will recommend the shareholders to declare a dividend of 6 per cent., which will absorb £22,208. 0s. 9d., to be distributed to the shareholders in accordance with Clause 77 of the Articles of Association.

3. The litigation in Germany still drags on, and, until some conclusion is arrived at, it is difficult to foresee whether a sound and remunerative business can be carried on in that country. The shareholders are aware that Germany is the only country on the Continent of Europe in which the Company now manufactures and sells lamps.

4. The Compagnie Générale des Lampes Incandescentes have established a new factory in Paris, which was brought into work last July, in which lamps are now being manufactured on a considerable scale. During the first six months of its existence, the Company worked under considerable disadvantages, having had to purchase the lamps required for their business, so that a small dividend only was earned, but there is every reason to hope that they will develop an increasing and profitable trade.

5. The Directors who retire by rotation are Mr. J. S. Forbes and Mr. E. W. Batt, who, being eligible, will offer themselves for re-election.

6. Messrs. Welton, Jones, and Co., the Auditors, will also retire, and will offer themselves for re-election.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The receipts of this Company for the week ended November 1st amounted to £4,506.

CUBA SUBMARINE TELEGRAPH COMPANY.—The estimated traffic receipts of this Company for the month of October, 1889, were £2,900, as compared with £3,316 in the corresponding month of last year. The receipts for the month of July, estimated at £3,000, realised £3,003.

DIRECT SPANISH TELEGRAPH COMPANY.—The receipts of this Company for the month of October amounted to £2,625, against £2,210 for the corresponding period of last year.

EASTERN TELEGRAPH COMPANY.—This Company's traffic receipts for the month of October amounted to £62,981, and to £55,742 in the corresponding period of 1888.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY.—The traffic receipts of this company for the month of October, 1889, amounted to £45,679, and to £38,660 in the corresponding period of 1888, an increase of £7,019.

EASTERN AND SOUTH AFRICAN TELEGRAPH COMPANY (LIMITED).—Notice is given, that on Friday the 15th inst, at noon, at the Company's offices, Winchester House, 50, Old Broad-street, E.C., 283 First Mortgage Debentures of £100 each will be drawn for payment on January 1, 1890. Notice will be given by advertisement of the numbers of the Debentures drawn.

ELECTRIC CONSTRUCTION COMPANY.—Application has been made to the Committee of the Stock Exchange for a special settling day in the shares of this Company.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic returns of this Company for the month of October amounted to £26,000. From January 1st to October 31st they were £229,200, against, in the corresponding months of 1888 and 1887, £226,200 and £220,880 respectively.

HALIFAX MUTUAL ELECTRIC LIGHT AND POWER COMPANY.—This Company, which is registered with a capital of £20,000 in 4,000 shares of £5 each, propose a first issue of 2,000 shares, payable 10s. per share on application, £1 per share on allotment, and the balance as may be required; purchase of the electric plant of Messrs. Blakey, Emmott, and Co. (Limited), and the Schmidt-Douglas Electric Company (Limited), at Halifax, and Amalgamated Halifax Supply.

SOUTH OF ENGLAND TELEPHONE COMPANY.—A half-yearly dividend on the Preference Shares, at the rate of 6 per cent. per annum, is announced by the Directors of this Company.

WEST COAST OF AMERICA TELEGRAPH COMPANY.—The traffic receipts of this Company for the month ended October 31st amounted to £7,725.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The receipts of this Company for the half-month ended October 31st were £2,717, against £2,767 for the corresponding period last year.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended November 1st, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,112.

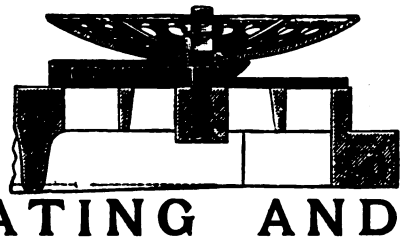
WOODHOUSE AND RAWSON UNITED (LIMITED).—The Directors announce a second issue of 10,000 ordinary shares of £5 each, 10,000 Preference of £5 each, at a premium of 5s. per share, and 400 Debentures of £100 each, at a premium of £2, being the balance of the capital of the Company. The prospectus announcing the formation of this Company was issued in July last, and it is stated that the wisdom of the amalgamation is shown by the fact that already more business of a profitable character has been offered than the capital issued enables the Company to entertain. The premiums received from the present issue will be carried to a reserve fund. The list closed yesterday for town, and this (Friday) morning for the country.

BUSINESS CHANGES.—Chutter and Gilbert, of Buckingham-street, Birmingham, electrical engineers, having dissolved partnership (Mr. Ralph B. Gilbert retiring), the business will be carried on in future by Mr. G. F. Chutter alone.

CHANGE OF ADDRESS.—Mr. Charles H. Yeaman informs us that his address is now 130, Bedford-street, Abercromby-square, Liverpool, and that he has removed from his London premises, 211, Isledon-road, Holloway, N.

PERSONAL.—Mr. Ernest Payne informs us that he has started business as an electrical and mechanical engineer, in conjunction with Mr. Carrington Smythe, at 140, Bath-street, Glasgow.

NEW VALVE



No Rubber, Percha, or Leather.

One-half the price of Rubber or Metal.

FOR CIRCULATING AND AIR PUMPS.

Unaffected by any Lubricating Oils. Does not Expand in diameter. Feed Water may be worked at any temperature Suitable for any shaped guards. Only one quality manufactured.

"12, John-street, Sunderland, 26th Sept., 1885.

"DEAR SIRS,—In reply to your letter of the 25th inst., the Valves I got from you have done their work well, and ARE AN UNQUALIFIED SUCCESS. I will continue to get them from you as required.—Yours faithfully, JAMES WESTOLL."

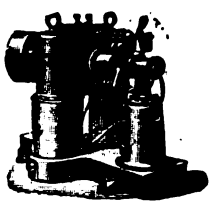
For further Testimony and Prices, apply to MOSSES & MITCHELL, 68-71, Chiswell Street, London.

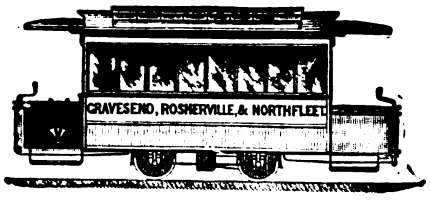
Digitized by Google

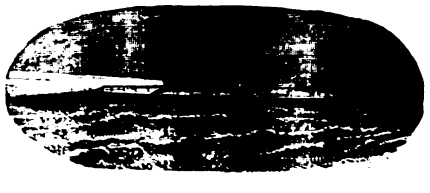
COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Wednesday, Nov. 6, 1889.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending Nov. 6, 1889.	
£			**TELEGRAPHS.**		£ s. d.		Highest.	Lowest.
1,770,360	Stock	12/6	Anglo-American	50½ 51½	4 17 1	Jan., Apr., July, Oct.	51⅛	50⅞
2,614,820	Stock	25/0	Do. Preferred	86½ 87½	5 14 3	,, ,,	89⅛	86⅛
2,614,820	Stock	...	Do. Deferred	16½ 17½	...	February	17	16⅞
130,000	£10	5/0	Brazilian Submarine	13 13½	5 18 6	Mar., June, Oct., Dec.	13⅜	13⅛
112,900	£100	5%	Do. 5 per Cent. Bonds	101 103	4 16 9	January and July	...	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	106 109	4 11 9	June and December.	...	...
16,000	10	9/0	Cuba Submarine	14½ 15	6 0 0	February and August	15	14⅜
6,000	10	10/0	Do. Preference 10%	20 21	4 17 9	,, ,,	20	...
12,931	5	2/0	Direct Spanish (£4 paid)	3⅜ 4½	3 15 4	March & September	4	...
6,000	5	5/0	Do. Preference 10%	9 10	5 0 0	April and October	...	...
60,710	20	3/6	Direct United States	10½ 10⅝	5 18 11	Jan., Apr., July, Oct.	10 7/16	10½
880,000	10	2/6	Eastern	13⅜ 14	4 12 0	,, ,,	14	13⅜
70,000	10	3/0	Do. 6 per Cent. Preference	15 15½	3 17 5	,, ,,	15½	15⅜
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock xd	106 108	3 14 1	May and November.	108¼	...
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	106 109	4 10 1	February & August	...	...
250,000	10	2/6	Eastern Extension	13⅛ 13⅜	4 14 6	Jan., Apr., July, Oct.	13 1/16	13⅜
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	102 104	3 16 1	February & August	...	...
473,000	100	5%	Do. 5 per Ct. (Austrln. Gov. Sub.) Debs. 1900	104 107	4 13 6	January and July	106½	104½
179,177	10	2/0	Globe Telegraph and Trust	8⅜ 9	5 11 1	Jan., Apr., July, Oct.	8⅝	8⅛
178,992	10	3/0	Do. 6 per Cent. Preference	14⅜ 14⅞	4 0 8	,, ,,	14⅝	14⅜
150,000	10	5/0	Great Northern	15⅜ 16	4 13 9	Jan., July, and April	15⅞	15⅛
17,000	25	12/6	Indo-European xd	40 42	5 19 1	April and October	42	...
9,000	8	4/0	Reuter's	7 7⅛	5 6 5	April and October	7 3/16	7
15,609	10	5/0	West African Telegraph	9⅛ 10⅛	...	...	9⅛	...
300,000	100	5%	Do. 5 per Cent. Debentures	99 102	4 18 0	March & September	100⅛	100
30,000	10	5/0	West Coast of America	10½ 11	5 0 0	January and July	10⅝	10½
150,000	100	8%	Do. Debentures 8%	122 127	6 6 0	June and December	...	...
88,321	10	nil.	West India and Panama	2⅜ 2⅞	...	...	2⅞	2 1/16
34,563	10	12/0	Do. 1st Preference 6%	12⅞ 12⅝	...	April and October	12⅛	12 1/16
4,669	10	+	Do. 6 per Cent. 2nd Preference	14⅛ 15⅛	...	...	15⅛	14⅛
45,181	15	9/0	Western Brazilian	10 10⅛	7 2 10	May & November	10 9/16	10
$1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage xd	111 114	6 2 10	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	100 102	5 17 8	March & September	...	...
			TELEPHONES.					
224,850	14/0	5%	Consolidated Telephone and Maintenance xd	1 1/16 1⅛	4 14 9	Yearly	...	...
220,000	£1	3%	Oriental (11s. paid)	5/16 7/16	3 15 11	...	...	...
*	*	nil.	National	6 6¼	...	...	6¼	...
55,000	5	3/0	United River Plate	5 5⅛	...	January and July	5⅜	...
			ELECTRIC LIGHT.					
23,692	5	2/0	Anglo-American (fully paid)	5 5⅛	...	February & August	...	...
79,934	5	6%	Swan United (£3. 10s. paid)	4⅜ 5⅛	...	...	5⅛	4⅞
500,000	10	...	Metropolitan Electric Supply (£3 paid)	5¼ 5⅜	...	...	...	...
			MISCELLANEOUS.					
37,350	12	12/0	Telegraph Construction and Maintenance	44 46	5 6 8	March and July	45	44½
41,600	10	10/0	India Rubber, Gutta Percha & Telegraph Works	18½ 19⅛	5 2 7	February & August	19	18⅝

† No dividend since May, 1880.







Before Ordering!

ELECTRICAL PLANT & ACCESSORIES

WRITE FOR THE FOLLOWING PAMPHLETS TO THE

UNITED ELECTRICAL ENGINEERING CO., Ltd.

Head Offices: 3, Princes Mansions, VICTORIA ST., WESTMINSTER.

"ELECTRICAL DISTRIBUTION."—Commercially considered, with Estimates.

"MACHINE DRIVING BY ELECTRICITY."—The Uses of Electro-Motors for Traction and Stationary Purposes.

"THE TELPHER SYSTEM OF CHEAP TRANSPORT," for Minerals, Goods and Passengers.

"ELECTRICAL SUPPLIES."—Prices and Particulars of the most approved Electrical Appliances.

ELECTRICAL PLANT ON VIEW.

Digitized by Google

THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 600.—Vol. XXIV. FRIDAY, NOVEMBER 15, 1889. Price Fourpence.

NOTES.

The secretary of the Edinburgh Electrical Exhibition has been informed that the Institution of Electrical Engineers has decided to hold a special meeting in Edinburgh before or after the meeting of the British Association at Leeds. This arrangement, if carried out, will have the advantage of securing the presence of some at least of the leading members of the Institution at the Exhibition, and if a programme is carefully prepared, the visit should prove a useful one. We are a little inclined to question whether attendance at Section G will not have somewhat exhausted the capacity of peripatetic electricians to receive and contribute information, but the occasion might be improved by discussing in conference matters of more special interest to electrical engineers.

The little difference of opinion between the electrical trade and the Edinburgh Exhibition authorities may be now considered to be in a fair way to an amicable adjustment. The report of the special committee of the Electrical Section was brief and to the point, and the Exhibition authorities, speaking through their general manager, Mr. Lee Bapty, seemed disposed to meet the wishes of the trade more than half-way. The request for free space was met by the proposal, that after all legal demands had been satisfied, any balance that might remain in the hands of the Exhibition authorities should be devoted to reimbursing electrical exhibitors. Mr. Lee Bapty was also able to say that there would be no difficulty about supplying current free of charge to any exhibit which required it in order to be properly shown, while he was prepared to advise his Council to undertake the insurance of the exhibits. In short, the Exhibition authorities displayed a laudable spirit of concession, and we have every confidence that any outstanding point will be settled in an equally businesslike manner.

We note with satisfaction the proposal made by the Special Committee that there should be no awards; or, at any rate, that if there are to be awards, steps should be taken to improve upon the present ridiculous system of granting medals wholesale after what at the best can only be a cursory inspection of the exhibits. In our issue of July 26th we hazarded the suggestion that Exhibition Committees might draw up certain conditions to be fulfilled by different apparatus, and should award certificates to such apparatus as came up to the required standard. A certificate of this nature, if the conditions were stringent and the tests carried out by competent persons, would carry considerable weight, and would possess the decided advantage of doing away with the invidiousness of competition. We are glad to see that there is every probability of some such system being adopted at Edinburgh.

Among the many useful proposals which were made at the meeting of the Electrical Section of the London Chamber of Commerce on Monday last was the one due to Mr. Albright, that the Electrical Section should act as Commissioners for the electrical trade at the Edinburgh Exhibition. This suggestion was embodied in a resolution which was carried, and will therefore take a practical shape without delay. The arrangement is one which will considerably diminish the labours of individual exhibitors, and if, in addition, it ensures punctuality in the sending in of exhibits, it will deserve well of the trade and of the public. Perhaps one of the best results of Monday's meeting is the convincing manner in which it will bring home to the electrical trade generally the potential possibilities of united action, whether for defence or offence.

Our esteemed contemporary the *Electrical World* devotes an article to describing the methods suggested by M. Nikola Tesla for rectifying alternating currents. We must confess to a certain amount of scepticism as to the availability of these methods for large currents. On another page of the same journal M. A. Gaillard describes an apparatus for effecting the same purpose, which has a close resemblance to a device described by Mr. Lane Fox some years ago intended to do this. It is obvious, however, that anything like mercury cups or spring contacts, however effective for currents of a few amperes in magnitude, will fail when larger currents are used. The commutation of alternating currents by a motionless commutator capable of dealing with currents of all magnitudes and various frequencies is a problem which may well tax the highest inventive skill, but these devices of M. Tesla do not seem very perfect solutions of the question. The method adopted of splitting the alternating current through two coils having magnetically saturated cores is very ingenious, depending as it does on the fact that the self-induction of the coil varies with the permeability of the core, and this varies with the induction through the core.

The letter signed "Observer" which we print this week, criticising the one signed "Telegraphy" in our last, will, no doubt, provoke a suitable rejoinder. But with regard to that

Digitized by Google

portion of "Observer's" letter which relates to ourselves, we may say at once that in according "sympathy" to "Telegraphy" we did not, and do not, suppose that he wished for a "preponderance" of the telegraphic element in the society. In reality the alleged ground of complaint is, not that the founders of the Society have been taken at their word, but that after faithfully keeping it, they find themselves reduced to silence. We do not assert that this grievance has been deliberately inflicted; but knowing as we do that it exists, we wish to make it known and get it rectified.

When we are asked, "Do you consider electrical industry important?" we don't mind telling anybody that we do; but when the Chairman of the meeting of Operative Electricians founds on this answer the further question, "Then, why don't you think the operatives able to estimate the status of their occupation?" we are tempted to reply, "Because they elected a chairman capable of putting such a question." But in reality we have not denied their ability or their right to estimate their status as highly as they please, and the higher it is estimated the better we shall like it. What we do deny is that their status will be heightened by a semi-political and wholly aggressive combination against their employers. Our correspondent is as vague concerning the objects of the Union as was Mr. Rowlands, M.P.; and the only point on which definite information is vouchsafed is that "no incompetent workman will be eligible for membership." Of this law the writer assumes that there is nothing in it "detrimental to the interests of the employer." We are not so sure about that. The assumption includes the right of determining the competency of the workman—a function which employers can exercise, one would suppose, with quite as much judgment, and certainly with greater impartiality. In practical operation such laws are usually intended to be read backwards—that is to say, No man will be deemed competent who is not a member of the Union.

If litigation between rival patentees may be considered as an outward and visible sign that their patents are worth fighting about, it is probable that we shall shortly have this proof at least of the value of the process of electric tanning. Just twelve months ago (*The Electrician*, November 9, 1888), reference was made in our "Scandinavian Notes" to the fact that tanning by electricity had been successfully carried out at Nordköping, in Sweden. A few months later (*The Electrician*, April 19, 1889) we published a brief description of the Worms and Balé process, which had been tried with encouraging results in France. The Worms and Balé process is, we believe, now being worked in this country by the British Tannery Company (Limited), and the threatened litigation, which is alluded to above, is between this Company and Mr. L. A. Groth, the inventor of the Swedish process, which has been in experimental operation at Messrs. Tebbitt Brothers at Bermondsey.

MM. Worms and Balé, it will be remembered, place the raw hides inside a revolving drum containing ordinary tanning solution, *plus* a little turpentine, and pass a current through the drum; and it is claimed for this method that it shows a 50 per cent. saving in cost, while the time required to effect a complete tan is reduced from several months to a few days. In the Groth electrical process the hides are suspended on a frame revolving in a circular vat, filled with ordinary tanning solution. It is claimed for the Groth process that it is the cheaper of the two, which is on the face of it very possible, since, instead of a heavy drum full of hides and liquid being continuously rotated, as in the Worms and Balé method, only a comparatively light framework is revolved; moreover, no addition to the ordinary tanning solution is required. Whether the Groth process is more effective, as is claimed, or even equally effective, is a question which will doubtless soon be settled by practical tanners. Meanwhile, whatever may be the respective merits of the two processes, there seems every probability that the value of the patents will be determined—as usual—in the Law Courts.

According to our Copenhagen correspondent, the General Telephone Company of Stockholm intends to start a separate class of cheap subscribers, whose annual subscription will be covered by the modest sum of 50kr., or about £2. 15s. 6d. It is hardly necessary to say that those who pay this reduced charge are not to be served as quickly as ordinary subscribers, and that they are only to be allowed a limited number of conversations per week. A limitation of the number of "calls" allowed might be endured with tolerable equanimity even in London; but a reduction in tariff would scarcely compensate for any further increase in the time at present taken to "switch on." Perhaps a modification of the Stockholm system might be tried here, and the annual subscription made to depend on the average time taken to make the necessary connections.

The technical point of law to which we referred in our issue of November 1st as delaying any further operations on the part of the two electric supply companies at Newcastle, is one which will doubtless be thoroughly appreciated by the legal humourist. It seems that the Town Clerk of Newcastle, while engaged in a refreshing study of the Electric Lighting Acts of 1882 and 1888, has made the interesting discovery that although there are certain penalties attached to the offence of neglecting to repair the streets which have been disturbed by the work of cable-laying, yet there is no authority that has power to set the law in motion. The question was immediately laid before the Board of Trade, who passed it on to their legal advisers for solution, and it has been decided that it will be necessary to amend the Acts. Meanwhile the licences are withheld.

The Editor of the *Revista de Telegrafos* writes us to the effect that there was no foundation for the report to which we alluded in our issue of October 18th, that a criminal had recently been executed at Ossuna, in Andalusia, owing to the delay on the Spanish land lines causing the announcement of his reprieve to arrive too late. No telegraphic reprieve was ever despatched, says our informant; consequently it could not arrive too late.

Digitized by Google

York.—The Corporation have decided to apply for an electric lighting Provisional Order.

Great Yarmouth.—The Corporation intend applying for an electric lighting Provisional Order.

Newcastle-under-Lyme.—The Corporation intend to apply for an electric lighting Provisional Order.

Dover.—The Town Council have resolved to apply for a Provisional Order for lighting the town by electricity.

The Cardew Voltmeter.—This well-known instrument is now being manufactured, under license, by the Edison-Swan Company.

Edinburgh Exhibition.—Mr. A. Bryson, M.I.E.E., has been appointed engineer and electrician to the Edinburgh Electrical Exhibition.

Wrexham.—The Town Council has decided to give consent, upon conditions, to the introduction of the electric light into the borough.

Formosa.—According to the British Consul at Tamsui, the new city of Tai-pei Fu, the capital of the island of Formosa, is lighted by electricity.

Japanese Enterprise.—Applications have been made for 12,000 shares in the Nippon Electric Light Company, Tokio, although only 4,000 are available for allotment.

Burton-upon-Trent.—At a special meeting of the Town Council, held on Monday last, it was decided that the Corporation should apply for an electric lighting Provisional Order.

Electric Lighting Provisional Orders.—The Board of Trade have, it is stated, already received over 300 applications for Provisional Orders for the electric lighting of various towns in Great Britain.

National Telephone Electrical Society.—On Friday evening last Mr. Alfred Coleman, M.I.E.E., delivered an inaugural address, on "The Future of the Telephone," at 40, Bennett's-hill, Birmingham.

Windsor.—The Corporation have given their consent to the applications for Provisional Orders of the Windsor and Eton Electric Light Company and the South of England House-to-House Electricity Company.

Ventnor.—At the last week's meeting of the Local Board, it was unanimously decided to offer every opposition to any electric lighting company who might seek for lighting powers within the area of the Board.

Nottingham.—At a special meeting of the Town Council on Monday last, the report of the Electric Lighting Committee, recommending that the Corporation should apply for a Provisional Order, was formally approved of.

Tunstall.—At the last meeting of the Local Board it was decided to oppose the applications of the Electric Trust Company and of the Municipal Electric Light and Power Corporation unless satisfactory terms were obtained.

West Bromwich.—The Gas Committee's report recommending that an electric lighting Provisional Order should be applied for, and that the sum of £20,000 should be raised to carry out the necessary works, has been unanimously adopted.

Birkenhead.—At a special meeting of the Town Council held on Wednesday last the Parliamentary Committee was authorised to take all the necessary steps to obtain a Provisional Order empowering the Corporation to supply the electric light to the borough.

Bournemouth.—The Bournemouth Improvement Commissioners have given their consent to the applications for Provisional Orders of the Anglo-American Brush Electric Corporation and the South of England House-to-House Electric Supply Company.

Edinburgh.—At a special meeting of the Edinburgh Town Council held on Monday a motion was carried by a small majority that it be resolved to apply for power to introduce electric lighting into the city when the legal difficulty now in the way has been removed.

Gravesend.—At a meeting of the Town Council on Tuesday consent was given to the applications of the Municipal Electric Power and Lighting Corporation, the South of England House-to-House Electricity Company, and the Electric Construction and Maintenance Company.

The Polytechnic.—There is to be an Exhibition at this Institution on Boxing Day, December 26th, of work executed by London apprentices, for which silver and bronze medals and money prizes are to be given. The Exhibition will remain open till January 11th. Further particulars are given in our advertisement pages.

Society of Arts.—The opening meeting of the Society of Arts will be held on Wednesday evening next, when an address will be delivered by the Duke of Abercorn, C.B., Chairman of Council. The second series of Cantor Lectures, to be delivered on January 20th and 27th, and February 3rd and 10th, is on "The Electro magnet," the lecturer being Professor Silvanus Thompson.

Sale by Auction.—On Friday next, November 22nd, Messrs. Chadwick and Sons will sell by auction at their gallery, 35, St. Martin's-lane, London, W.C., a complete electric lighting plant of 1,500 lights, Messrs. Gatti, of 436, Strand, who have had the installation at work, having decided to put down a much larger plant. Further particulars will be found in our advertisement columns.

Mason College Engineering Society.—The annual meeting of this Society was held on October 30th. We are glad to hear that the Society is in a very satisfactory condition, both financially and as regards the nature and technical value of the Papers that have been read and discussed during the past year. After the election of officers for the ensuing year a Paper was read by Mr. E. L. Joseph, entitled "Electrical Novelties at the 1889 Birmingham Exhibition."

Institution of Electrical Engineers Students' Meeting.—The first meeting of the latter part of the Session took place on Friday evening last, Mr. Dykes in the chair. An instructive discussion took place on "The Different Systems of Distribution Employed in London at the Present Time," in which the following gentlemen took part:—The Chairman, and Messrs. Barton, Childs, Horn, Jacob, Müller, Poynton, and Walker. The next meeting will be held on Friday, November 22nd.

Telpher Line at Tirupati.—The Mohant, says the *Indian Engineer*, has long had a telephone line in work, and this has proved of great use in conveying messages to and from Upper and Lower Tirupati. So well pleased has he been with the result of this enterprise that a scheme has now been arranged for fixing a telpher line. The cars will be available for either passenger or luggage traffic at a nominal charge, the time occupied in transit from Lower Tirupati to the site of the temple being calculated at only about 45 minutes.

Dublin.—The Corporation of this city have not yet received from the Board of Trade the permission applied for to supply electricity for private lighting purposes. The Tramways Company and the Alliance Gas Company are opposing the application of the Corporation to the Board of Trade, with a view of getting clauses inserted guarding their interests. The Corporation have not yet decided on a site for their electrical depôt, but as they have at least two of their own available, no difficulty on this head can arise.

Rome.—According to the Rome correspondent of the *Standard* a contract has been signed between the Commune of Rome and the Anglo-Roman Gas Society for the illumination of Rome and the suburbs by electric light. One hundred and sixty-seven electric lights will take the place of 706 gas lights, at an increased expense of nearly 26,000fr. annually. The contract provides that the whole of the works for the complete illumination of the city and suburbs shall be in working order in one year and eleven months from now.

Leamington.—At the last meeting of the Corporation the Watch and Lighting Committee recommended the continuance of the engagement with the Midland Electric Lighting and Power Company, subject to a quarter's notice on either side on

Digitized by Google

any quarter day. It is stated that Messrs. Chamberlain and Hookham have offered to erect a number of arc lamps on the Parade in lieu of the small lamps now in use, and to effect other improvements, and this has influenced the Corporation in withdrawing the notice to terminate the contract, which would have expired at Christmas.

"The India Rubber World and Electrical Trades Review."—This is the title of the latest American addition to the ranks of the technical journals. The first number of the *India Rubber World* is a distinctly good one, containing, as it does, more than 20 pages of very readable reading matter. We note in the customary editorial proclamation on the first page the satisfactory announcement that the *India Rubber World* intends to devote its special attention "to that important branch of electrical development which has been most neglected and most needs improvement, namely, the intelligent and progressive *mechanical* adaptation of electricity."

Berlin.—The report of the *Berliner Electricitätswerke* for the year ending June 30, 1889, shows that this Company continues to make very satisfactory progress. The net profits for the year 1888-89 amount to £26,300, against £14,120 for 1887-88, the gross receipts being respectively £57,300 and £31,840. In 1886 the Company supplied current to 12,000 incandescents and 36 arcs. By the middle of last year the number of incandescents had risen to 37,460, and by June, 1889, the incandescents numbered 46,710 and the arcs 144. It is anticipated that current will be supplied during the coming winter to 60,000 incandescents, and also to a large number of motors.

Tenders Open.—For the supply of the following articles during six months ending June 30, 1890, delivered carriage paid at the Stores, at York, for the North-Eastern Railway Company:—1. Telegraph apparatus. 2. Telegraph wire and line stores. Payment for each month's delivery will be made at the end of three clear months, or in cash less 2½ per cent. discount. Forms of tender may be obtained on application. For the supply of creosoted Swedish or Norwegian fir poles of stout specification for delivery in Scotland during next six months, for the National Telephone Company. Particulars may be obtained on application to the Secretary of the Company, Oxford-court, Cannon-street, London.

The Thomson-Houston System of Electric Traction.—We are informed by Messrs. Laing, Wharton, and Down that they have made arrangements for the "energetic introduction" of the Thomson-Houston system of electric traction into this country, and that Mr. Graff Baker has undertaken the personal management of this department. A system which in America is at work on 53 lines, and will shortly be in operation on 25 more, certainly merits the attention of our tramway companies. Messrs. Laing, Wharton, and Down have also issued a well-illustrated pamphlet describing the advantages of electric traction, and containing numerous testimonials from the presidents of American street railway companies and others.

Stoke-on-Trent.—A special meeting of the Town Council was held on Thursday last week to consider the question of electric lighting. Notices had been received from two companies. In moving that the consent of the Corporation should not be given to such Provisional Orders, Alderman Leason said that the town possessed a gasworks for which the rates were liable to the extent of £67,000. It therefore behoved the Council to resist the efforts of outsiders to come into the borough for the purpose of depreciating the value of their property. He thought it would be advisable for the Corporation themselves to apply for a Provisional Order empowering them to supply electricity, and this, while keeping away outsiders, would give them an opportunity of considering whether they should extend the gasworks or light the congested parts of the town by electricity. The motion was carried unanimously.

Exports of Electrical Apparatus, &c.—The Board of Trade Returns for October show that the smaller exports of the last few months, compared with the corresponding periods of 1888 and 1887, were followed by a very considerable movement last month. The total exports of telegraphic wires and apparatus connected therewith from January 1st to October 31st have been twice as large, judged by value, as the corresponding exports last year, and have been much heavier than in 1887. The following is a comparative statement for the past three years:—

	1887.	1888.	1889.
Jan. 1st to June 30th	£188,812	£244,213	£576,456
July 1st to Sept. 30th	468,252	152,926	117,460
October	31,475	17,938	205,603
Ten months	£688,539	£415,077	£899,519

There appears to be an error in the addition of the 1888 figures given in the Board of Trade Returns. The monthly figures give a total of £415,077, and not £414,177, as given in the Return.

The New Works of the Electric Construction Corporation at Wolverhampton.—The contract for £40,000 to erect the new works of the Electric Construction Corporation, at Bushbury, near Wolverhampton, has been secured by Mr. Henry Lovatt. The site consists of about 24 acres of land. A siding will connect the works with the London and North-Western Railway, and the buildings, which will cover between four and five acres of ground, are so devised that they can be extended without interfering with the operations of the workmen or the roofs of the different structures. The offices will contain board room, consulting room, telephone room, photographing room, two rooms for clerks and draughtsmen, three waiting rooms, and apartments for the secretary and manager. The manufacturing buildings will include machine shop, 300ft. by 90ft.; five erecting shops, 300ft. by 30ft.; foundry, 160ft. by 80ft.; brass-foundry, 65ft. by 40ft.; blacksmith's shop, 84ft. by 30ft.; pattern shop and stores, each 100ft. by 32ft.; chemical laboratory, 60ft. by 20ft.; together with other buildings. The buildings will be erected of Tibbington red brick, with stone strings and facings of blue brick, and the buildings are to be completed within seven months.

A Simple Method of Testing Wire Insulations.—The ordinary method of comparing the value of insulations by determining the insulation resistance in megohms, is, no doubt, the most scientific way, says Mr. H. B. Brooks in the *Electrical World* of New York, but it requires expensive apparatus and a degree of skill which is not usually found in the average central station staff. The writer has for some time made use of a method which requires hardly any apparatus, provided access may be had to an E.M.F. of from 100 to 200 volts. Samples of the wires to be tested are measured off in equal lengths, say 5ft. each. Commencing at a point about 6in. from one end, a bare copper wire is wound on over the insulation in an open spiral, ending at a point about 6in. from the other end. At this point a knot is tied in the bare wire to prevent its sliding or uncoiling, and about a foot of it is left for a connection. About half an inch of the insulation is removed from one end of the test wire. Each wire having been thus prepared is doubled up several times, so that it may be placed in a glass jar, with the portions at each end not covered by the spiraled wire situated above the water line. Water is then poured into the jars, and the end of the outside spiral is connected direct to one pole of a dynamo, and the copper core inside the insulation is connected through a piece of fine fuse wire to the other. The time of turning on current is then noted, and also the time when each wire "leaks" enough to burn off its safety fuse. This is a simple and practical way of comparing insulations by exposing them to the same kind of strain they receive in practice, but more severe. In a recent test made by the writer, "undertaker's" wire lasted about 40 hours; a cheap line wire nearly the same time; a good line wire 275 hours, and a still higher grade of wire 895 hours.

American Electrical Apparatus in the Transvaal.—We have been informed, says the *Engineering and Mining Journal* of New York, that the Forbes Reef Gold Mining Company, of Transvaal, South Africa, have recently ordered from the Sprague Electric Railway and Motor Company, of New York, through Messrs. Chester and Gibb, mining engineers, of London, a complete electrical equipment, including four Sprague long-distance transmission motors and three dynamos, for transmitting 140 horse-power over a distance of three miles. The

Digitized by Google

primal source of power is a waterfall, situated three miles distant from the mine; at this point will be placed three Pelton wheels, provided by Frazer and Chalmers, of Chicago. To each of two of these wheels will be belted one far-transmission constant-potential 50-kilowatt Edison dynamo. To the other wheel will be belted a dynamo of the same type and voltage as the others, but of 40,000 watts capacity. These dynamos are similar in appearance to the standard Edison dynamo for incandescent lighting, and are built at the Edison Machine Works, but their winding is especially adapted according to the Sprague method for the work of long-distance transmission of power. The wires, which are insulated, will be carried overland across country on wooden poles to the point of distribution where are located the four long-distance transmission motors of the constant-potential type, one of 80 and three of 20 horse-power capacity each. These motors are divided into two groups, one single 20 horse-power motor forming one group, and the other two 20 horse-power motors and the 80 horse-power motor forming the other group. Each group is supplied with current by a separate set of wires. The efficiency of the entire system, from the turbine pulley to the mining machines at the farther end, is about 70 per cent.

Ventilating Electrical Conduits.—In view of the difficulties which the New York Board of Electrical Control is meeting in the construction of underground conduits, it is interesting to note a device which has successfully prevented the explosions which at present form such a prominent feature in New York, and which were at one time equally troublesome in Chicago. After considerable experimenting, a system of ventilation was adopted which was the result of the combined efforts of Prof. Barrett and his assistant, David M. Hyland, and the arrangement is now in operation in the basement of the city building at Chicago. The tunnel from the main conduit of the system carries the necessary conductors to the building. This conduit opens into a chamber provided with an air-inlet and a vent connected with a flue, and so arranged that all objectionable gases coming through the tunnel are carried up the flue. The cables are carried through the sides of the chamber in any convenient manner, all spaces about the cables as they pass through the walls being practically air-tight, so that there may be no escape of gas into the building. The flue is preferably one of a stack of chimneys, so that it may be heated, causing a strong draught of air through the chamber. The gas in the conduits is thus caused to circulate, and dangers from explosions throughout the system, as well as in the building, are avoided. It is of importance to cause the gases throughout the system of conduits to circulate, since they are usually of such specific gravity that ventilation at the manholes does not have the desired effect. This simple device is applied to the Chicago system of underground conduits, and not only prevents the explosions in the building, for which it was specially designed, but is also beneficial throughout the system, no explosions having taken place at the manholes or at other buildings connected with the same system since its application, and the injury to the cables heretofore caused by the action of the gases has practically ceased. A somewhat similar device is also employed at Brooklyn with marked success.

The Electrolysis of Distilled Water.—The following is abstracted from the graduating thesis of Mr. M. E. Duler, of Cornell University:—"In these researches I employed distilled water contained in glass tubes with two branches, which, after several months, imparted no alkaline character to the water. The electromotive force used was about 100 volts. As electrodes—(1), an anode and cathode of platinum; (2) anodes of very different metals, principally nickel, cobalt, iron, copper, cathode of platinum; (3) anode of platinum, the cathode of tin, bismuth, copper, lead, mercury, aluminium, &c. In the first case, with a cathode of fine wire, the anode being a large plate, the electrolysis of the water gives off only hydrogen for several days. In the second the anodes are attacked, and at first give off protoxides, forming a substance at the positive poles, which is green with nickel, pink with cobalt, and blue with copper; after several hours the protoxides change to peroxides. If continued for several months, the oxide at the positive pole becomes partially reduced; thus peroxide of nickel forms protoxide, becoming green; that of cobalt, which was maroon, becomes pink; and that of iron loses its reddish colour, and turns almost white. These actions are comparable to those produced on certain peroxides by oxygenated water. In the third case, the negative electrode becomes oxidised. A negative electrode of copper becomes covered with a deposit that almost stops the passage of the current, even using 120 volts. Lead becomes covered with gray tufts, giving rise to protoxide of lead, which seems to flow from the electrode like white pulp. With mercury as the negative electrode, the free surface becomes covered with pasty protuberances having the brilliancy of mercury; these give off hydrogen, and more than an hour after the cessation of the current they give off more. Aluminium is violently attacked, changes into alumina, loses all cohesion and falls to the bottom of the vessel in gray flakes and dust. These experiments, and especially that relating to aluminium, lead me to the conclusion that metallic hydrures are formed at the negative pole, which the water destroys upon the formation of oxide and the liberation of hydrogen."

The Mariner's Compass—Historical.—Although a knowledge of the directive powers of the loadstone was, it is believed, known to the Greeks and Romans, they certainly made no practical use of it. It was, however, known in China, as well as throughout the East generally, at a very remote period. In fact, the Chinese claim that it was discovered B.C. 2634. Humboldt, in his "Cosmos," says that a thousand years before our era the Chinese had already magnetic carriages, on which the movable arm of the figure of a man continually pointed to the south, as a guide to find the way across the boundless grass plains of Tartary. At any rate, 700 years before the use of the mariner's compass in the European seas, Chinese vessels navigated the Indian Ocean under the direction of magnetic needles pointing to the south. The story that Marco Polo first brought the compass to Europe was long ago disproved, since it is clearly shown that the instrument had been used in European seas about 60 or 70 years prior to the time Marco Polo set forth on his journeyings. Humboldt considers it probable that Europe owes the use of the compass to the Arabs, and that they, in turn, were indebted for it to the Chinese. The first allusion to the mariner's compass in any English work occurred in Alexander Neckham's "Treatise on Things Pertaining to Ships," published some time during the close of the 12th century. The earliest mention of the use of the instrument occurs in a poem by Guyot of Provence, in 1190. About 1260, Brunetto Latine notes that the needle was very useful at sea, and calls attention to the unreasonable prejudices which deterred the navigators from adopting it generally. Raymond Lully, of Majorca, in 1286, made the statement that the seamen of his time employed the "magnetic needle." In the reign of Edward III. the magnet was known by the name of sail-stone, or adamant, and the compass was called the sailing-needle or dial. A ship named the "Plenty" sailed from Hull in 1338, and was steered by the sailing-stone. Chaucer, who died in 1400, mentions the compass, and states that sailors reckon 32 points of the horizon, which is the present division of the card. In the beginning of the 14th century, Flavio Gioia, of Amalphi, made a great improvement in the instrument by the simple device of suspending the needle on a centre and inclosing it within a box, and this is how he came to be considered as the inventor of the mariner's compass. The compass used by mariners in the 12th and 13th centuries was very uncertain and unsatisfactory, and consisted simply of a magnetic needle floating in a basin by means of two straws or a small piece of cork. Flavio Gioia's improvement brought the compass into general use. Since that time it has been gradually improved and perfected, and most of the improvements and discoveries in this direction have been made by Englishmen. Thus, R. Norman, of Wapping, discovered the inclination of the needle. The declination, or variation, was discovered by Stephen Burrnars, of Limehouse, and Gillebrand, of Gresham College, made the first accurate determination of this quantity. The first variation chart is due to Halley. Coming down to more recent times, the names of Flinders, Barlow, Airy, Evans, Smith, Napier, Rendell, Towson, and Thomson occur as men who have devoted much time and study to improving such an apparently simple instrument as the marine compass.

Digitized by Google

SIR WILLIAM THOMSON'S CHAIN OF ELECTROSTATIC VOLTMETERS.

BY ANDREW W. MEIKLE, M.A.

(*Continued from page 7.*)

The sensibility required for the different ranges of the multicellular voltmeter is obtained by varying the number of cells and vanes, the cross-section of the suspending wire, and also the length of wire used. At first a little difficulty was experienced in obtaining constancy in the wire suspension, and a little trouble was consequently given by having to reset the zero from time to time. This difficulty was caused most probably by the straining of the wire in the process of drawing, so that some little time elapsed before it came to a normal condition. A very carefully drawn iridio-platinum wire is now used, and is subjected to a preliminary tempering (*ageing*) by heat, longitudinal tension, and torsion. The results with this suspension have been most satisfactory, and the standard instruments which are constantly in use now give no trouble from changes of zero.

Standardising of the Multicellular Voltmeters.

For low potentials the instruments are graduated by joining their terminals to those of a standard anti-inductive resistance through which a current, measured by one of Sir William Thomson's standard Centi-ampere Balances, is passed. The arrangement is shown diagramatically in Fig. 4. A rheotsat of platinoid wire is joined up in the circuit, in order to vary the current to any desired value. The standard resistance used

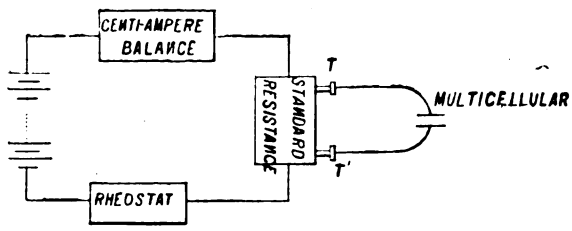


Fig. 4.

is wound with platinoid wire, and its temperature variation is very nearly one-fortieth per cent. per degree centigrade, so that any uncertainty in the estimation of the temperature may be neglected. The Centi-ampere Balance is the standard used in the Physical Laboratory of Glasgow University, and its accuracy is certainly within one-fifteen per cent. These particulars are given simply to show that uncertainties in the standardising apparatus have been as far as possible removed. The Multicellular is joined up to the terminals T T′ of the standard resistance, and shows the difference of potential between them, which at any one time is equal to C × R, where C = current through the resistance as shown on the balance, and R = value in ohms of the standard resistance.

The number of ohms in the standard resistance is varied from time to time so that the deflection on the balance may be sufficiently large to enable any possible error in the reading of the position of the weight to be so extremely small as to be neglected. By this method, and using the battery power at our disposal, it is possible to push the graduation of the instruments up to 140 volts with great accuracy.

For ranges above this point a volta pile is used to augment the potential, as shown in Fig. 5. This pile consists of zinc-copper couples fixed to a vulcanite frame in such a manner that when their extremities are dipped in water the liquid is drawn up by capillary action, and a chain of little cells is formed, each of which gives about 0·9 volt. These volta piles are made up in sets of 200 couples, and the stand containing each set measures about 50 by 10 centimetres. We have found them to give excellent results, and can by those we have obtain over 1,000 volts. The zinc end of the pile is joined to the positive terminal T of the standard resistance, and a voltmeter, A, formerly graduated by the method explained above, is joined up to the same terminal and to a point in the pile such that it gives a convenient reading on a sensitive part of its scale—say, for example, 100 volts. Another voltmeter, B, also graduated to 140 volts, and whose graduation it is wished to extend, is then joined to the other terminal, T_1, of the standard resistance and the same point of the pile as A. The Multicellular B then measures the difference of potential between the terminals of the standard resistance *plus* the difference of potential due to the portion of the pile measured by the Multicellular A. By this means the graduation of Multicellular B may be pushed up to 240 volts. By substituting Multicellular B for A and using it to measure a higher number of volts, a third instrument can be graduated up to 380 volts, and so on. By this means a chain of standards has been obtained giving readings on sensitive portions of their scales throughout the entire range, so that instruments

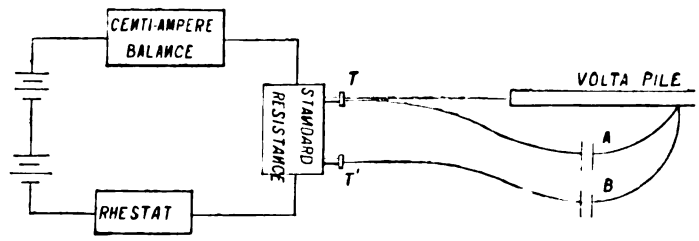


Fig. 5.

can now be graduated by direct comparison; but two of a lower grade, X and Y, joined in series as shown in Fig. 6, are always used in the graduation of a higher range instrument, Z, so that their indications may be amply sensitive as compared with the one being standardised. These standards of course undergo periodical checkings, and are constantly being compared one with another to make sure that they have not been injured in any way since their calibration.

These voltmeters have now been in use in the Physical Laboratory of Glasgow University for some time, and have proved a great convenience, as for many purposes they save a large expenditure of time which would be taken up in making temperature corrections, calculations, &c., were other voltmeters used. We have been able by using them to determine by direct experiment how far other voltmeters could be relied upon to give accurate measurements on alternating circuits under varying conditions, as to period, temperature, &c. The instruments, in

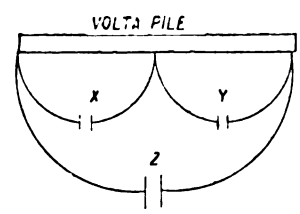


Fig. 6.

conjunction with the volta pile, have also proved very useful in standardising the electrometers used in the investigation of atmospheric electricity, by Messrs. Maclean and Goto, on which a preliminary note was communicated by Sir William Thomson to the British Association (*The Electrician*, September 20th, p. 500).

The Electrostatic Balance.

The arrangement of the parts of this instrument is shown in Fig. 7. The first portion of the condenser in this instrument is a brass disc, B, which is supported from a slate base-plate, S, on three glass pillars, P. The disc is provided with the well-known Thomson "hole slot and plane" arrangement, so that it always rests in exactly the same position on its supports.

A wire thickly covered with india-rubber passes from a terminal, T, through a glass tube, C, C, and makes connection with the disc by a spring contact; this glass tube being filled with paraffin to prevent the lodgment of moisture and give

Digitized by Google

great resistance to disruptive discharge. A sheath formed by a short piece of glass tube pulls up over the terminal T, and protects it from being touched by accident. The slate base-plate is provided with three screw levelling feet.

A brass case fits upon the slate base-plate, and fixed to its top is a metal scale with a glass front which contains the indicator and scale. The movable part V is a square aluminium plate, supported by two long links which pass through a slit in the top plate of the case to two knife-edge stirrups on one end of the counterpoised indicator I. The whole movable portion is supported by knife edges on two brass pillars, and has a short arm, A, with a knife-edge stirrup at its extremity attached to its axis. The weights which fix the constant of the instrument hang on this stirrup.

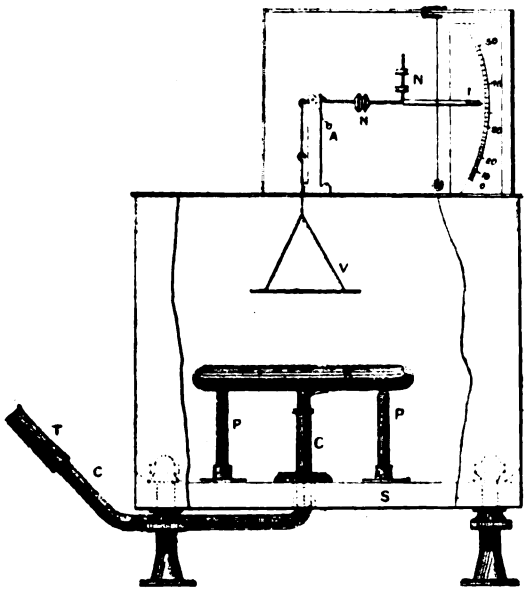


FIG. 7.—The Electrostatic Balance

The instrument is usually graduated by direct comparison with a standard Vertical Scale Voltmeter, and has a scale with divisions corresponding to equal differences of potential. The scale is graduated from 0 to 50, and three weights are provided, such that, with the first alone hung on, the constant is 250 volts per division, with the first and second weights on it is 500 volts per division, and with all three weights on 1,000 volts per division.

(To be continued.)

ELECTRIC TRACTION ON THE BARKING ROAD.

At the invitation of the directors of the Electric Traction Company and the North Metropolitan Tramway Company we recently visited the installation at Barking, and by the courtesy of Mr. Macpherson, the managing director of the Traction Company, and Mr. Thomas Frazer, the managing engineer, we are enabled to give an account of what is being done there.

As our readers are aware, a small section of line is being worked under contract with the Electric Traction Company, by means of cars carrying accumulators. The contract price is 4½d. per car mile, which price includes the driver's wages. The North Metropolitan Company estimate the cost of working similar cars (accommodating 52 passengers) by horses at 5½d. per car mile, so that the saving effected by the use of electric cars is a very substantial one. The total number of car miles which the Traction Company were under contract to perform up to October 31st, was 20,280, while the total actually performed was 19,877—a difference of about 1 per cent. This is a very satisfactory performance when the want of experience in the work is taken into account. We are, therefore, not surprised to learn that the Tramway Company have decided to apply for Parliamentary powers to work all of their systems by electricity.

The cars have the same appearance as ordinary horse cars. The batteries are carried underneath the seats, and are accessible from the outside; flaps or doors running half the length of the car, and hinged at the top, serving to cover in the cells, and give the car the ordinary appearance when on the road. Each car carries two batteries of 48 cells, or 96 cells in all. The cells are arranged on 12 trays, six being accommodated under each row of seats. There are thus eight cells on each tray, which are permanently connected up in series, and the terminal leads connected to brass brackets, which are provided at each end of the trays. When the cells are in position in the cars, these brackets rest upon brass contact plates, which are fixed on the top of wooden rails, which carry the weight of the trays: the mere act of pushing the trays into position, therefore, makes the necessary connection. The four leads from the batteries are brought together to a compound switch, which constitutes the chief controlling device of the car.

This switch is of very ingenious construction. By the movement of a single key it connects the batteries—either in series or parallel, and with a variable amount of resistance in circuit, with the motor. The key is provided with a handle at right angles to the key shaft, and is passed through a hole in the cover of the switch box. The handle stands horizontally when there is no connection between battery and motor. Suppose the handle to be turned upwards: during the first part of the movement a device is operated which connects the two batteries in parallel; continuing the movement this device becomes by a clever arrangement, disengaged, and a radial contact bar makes the connection with the motor circuit through the whole of the variable resistance. The key can now be rotated several steps further, each step reducing the resistance in circuit until the latter is *nil*: this is the *modus operandi* for starting the car. When sufficient speed is attained, the driver turns the handle back through all the stages mentioned, passing the horizontal position, and on to the other half of its range of motion. As the central position is passed the motor is switched off, the battery connections are altered from parallel to series, and the motor switched on again, the connection being made, as before, first through the whole of the resistance, which is reduced as the handle moves on, to nothing. The sparking is diverted from the contact surfaces proper, and taken on the ends of adjustable pieces of $\frac{5}{16}$in. diameter steel rods, in the newer designs of the switch.

The motor can be connected with the cells in parallel by one move of the handle, and with the whole of the cells in series by an opposite movement. The drivers are the same as have been driving the horse-cars, and it is, therefore, not surprising to hear that some of the difficulties which the Traction Company's engineer have had to contend against have been due to the motors being occasionally switched full on to the series battery, without allowing time for the speed to get up.

The reversal of the motor is effected by means of a separate lever, which changes the brushes. A switch and reversing lever are fitted at each end of the cars. The cars are lighted by means of two 16 candle-power incandescent lamps, and the light is quite sufficient to enable passengers to read with comfort.

A steep incline is encountered where the road crosses one of the main sewers, and after this a long, steady rise has to be dealt with; but the cars are easily able to exceed the speed of the horse-cars on any part of the road when the other traffic permits.

A fully-charged set of cells suffices for half a day's work, or about thirty car-miles. The partially exhausted set of cells is withdrawn, and a newly-charged set installed, in the space of three minutes with ease, as we ourselves witnessed; the time of absence allowed from the track being seven minutes. In order to change the cells the car is stopped just outside the tram depôt, the flap-doors are fastened up, and the car moves on between two rows of benches which are fitted with cross-rails, carrying contact plates, similar to those under the car seats. The rails on the benches and in the cars are of the same height, and the car being adjusted between two sets of rails the trays of cells are readily drawn out on to the benches, and are left ready connected up for charging. The car is now moved on to

Digitized by Google

a set of charged cells, which are as easily pushed off the bench rails into the car, which is now again ready for the track. The whole of the cells are charged up at night, an operation which usually takes about ten hours.

The charging plant consists of a 50 horse-power Immisch dynamo driven by a Davey-Paxman undertype engine. A second engine is already in position, and a second dynamo is in course of construction, so as to duplicate the plant. The coal consumption averages about 20cwt. per night, which, with the figures given by Mr. Frazer, the managing engineer, works out to about 6lb. of coal per electrical horse-power, delivered at the dynamo terminals. A considerable increase in the efficiency of the plant resulted from coating the boilers with silicate cotton, and then lagging.

THE IDENTITY OF LIGHT AND ELECTRICITY.*

BY M. H. HERTZ.

The proposition which I intend to develop to-day is that light is in its essence an electrical phenomenon. Deprive the universe of electricity and there would be no light. Suppress the luminiferous ether and electric and magnetic forces would no longer have effect. Many experiments only mark one stage in the development of this theory, and it is the complete history of the theory, not one of its phases only, that I wish now to trace.

What is light? Since the researches of Young and of Fresnel we know that it is an undulatory motion, we know the speed of the waves and their length, we know that they are transverse waves—in short, we know all the geometrical conditions of the motion. All these facts are absolutely beyond doubt. For the physicist the undulatory theory is, humanly speaking, certain, and everything which results therefrom is also certain. It is certain that space is not a void, but filled with a substance capable of taking up vibration—namely, the ether. But if we possess very clear notions of the geometrical conditions of the phenomena which take place in this substance, their physical nature, on the other hand, is very obscure, and what we know of the properties of the substance itself is full of contradiction. Comparing the luminous waves to sound waves, they were considered elastic; but in fluids we only observe elastic waves under the form of longitudinal waves. Transverse elastic waves are impossible in fluids, the very nature of the substance making them impossible. We are, therefore, obliged to admit that the ether behaves like a solid body. But, again, taking into consideration the motion of the planets, we are obliged to assert that the ether acts as a perfect fluid. These two results are evidently contradictory. Without seeking to gloss over this difficulty, let us pass on to electricity: perhaps the study of its nature will enable us to get over this obstacle.

What is the nature of electricity? The solution of this problem is arduous, and excites interest far beyond the restricted sphere of scientific men. Most of those who put this question do not doubt the actual existence of a substance called electricity, and expect a description and an enumeration of the properties and qualities of this singular substance. For the scientist the problem assumes another aspect. Is there such a thing as electricity? Are not electric phenomena connected with the properties of ether and ponderable matter? The state of our knowledge does not yet permit us to answer this question in the affirmative.

The old double-fluid theory served its purpose well until at the beginning of the present century the reciprocal action of magnets and currents and other newly-discovered phenomena necessitated further extensions of the theory which immediately deprived it of its great simplicity. It was difficult to get out of the magic circle of this theory. It did not lead to truth, but it required a great man to resist the current of scientific opinion. It was necessary to study all these phenomena without preconceived ideas, and to start from what was observed and not from what was read. Such was the path followed by Faraday.

Electric and magnetic forces became for him the only tangible realities, and electricity and magnetism descended to the rank of objects whose existence was very doubtful. Considering "lines of force," as he called them, independently of their cause, he saw in them different conditions of space: tension, whirls, currents. When it was objected that space was empty, and therefore was in a state of absolute repose, he answered, Is space empty? Does not the transmission of light oblige us to consider it as full of matter? Does not the ether which transmits luminous waves experience modifications of condition which we perceive in the form of electric and magnetic phenomena? Is there a relation between these modifications and these vibrations? Are not light waves the scintillation of these lines of force? Such were some of the questions put by Faraday.

One of his principal investigations was to determine whether the transmission of electric and magnetic forces was instantaneous. On this point Faraday arrived at no solution. If he had succeeded in doing so his theory would have triumphed from its birth; the relation between light and electricity would have immediately become so evident that it would have received universal credit. Such an easy and rapid triumph was, however, not to be. Experiment gave no answer to the question, and the theory in vogue did not accord with Faraday's ideas. In affirming that electric forces could exist independently of corresponding fluids he contradicted the system generally believed in at that time. It seemed that a discussion of one or the other of these hypotheses must necessarily be a barren speculation. What admiration, therefore, must we not have for the man who knew how to co-ordinate these two hypotheses which in appearance were very far apart. This man was Maxwell. His work, published in 1865, is known under the title of "The Magnetic Theory of Light."

One cannot study this theory without having at times a feeling that mathematical formulæ possess a life of their own, a special reason. They seem at times more intelligent than ourselves—more intelligent, indeed, than he who establishes them; they tell us more than does the man who discovers them. But such comprehensive formulæ could not have been discovered unless the discoverer had possessed the capacity of seizing upon the slightest particle of truth which Nature allowed him to see. Such a capacity was possessed by Maxwell.

This is the question with which we are concerned. Electricity in movement produces magnetic forces; magnetism in movement produces electric forces; and these effects are only appreciable at great velocities. Hence the idea of velocity enters into the relation which connects electricity and magnetism, and the constant which determines this relation has been found over and over again to be the same as the velocity of light. By anyone, except a disciple of Faraday, this coincidence might be set down to chance, but to such a disciple the reason of this fact is undoubtedly that the same ether transmits light and electricity, and therefore the two velocities which had been determined *could* not be anything else but equal. From Maxwell's time the most important optical constant existed amongst electric formulæ. Maxwell set to work to strengthen the band uniting these two phenomena. He enlarged his formulæ so as to make them embrace at the same time all known phenomena and a large class of hypothetical phenomena. If anyone rejected the Maxwellian theory of electricity, it was no longer necessary for him to admit Maxwell's views on the subject of light. In the same way, if anyone affirmed that light was a phenomenon of an elastic nature, Maxwell's theory of electricity became impossible. But if one studied his system without pre-occupying the mind with the ideas in vogue, it was easy to see that all the parts lent each other mutual support, like the stones of a gigantic arch thrown across the unknown, and uniting two ascertained truths. It is true that the difficult nature of the theory did not permit it to acquire many adherents; but when its meaning was fully grasped, it was followed up to its logical consequences, and the value of its fundamental hypotheses was then fully seen. But for a long time investigations were necessarily confined to a few accessible propositions. The demonstration of the possibility of obtaining light directly from electric or magnetic effects would have been a striking confirmation of the theory. The demonstration of the existence of electric or magnetic undulations propagating themselves in a manner similar to luminous undulations would have been another argument of equal value. It was my good fortune to take part in this latter work, and it is to this circumstance that I owe the honour of addressing you to-day, and you must excuse me if I draw your attention only to my own particular work; but time obliges me to confine myself to one single series of investigations.

Was it really so difficult to say that the propagation of electric forces was not instantaneous? Was it not possible to discharge a Leyden jar and observe if the oscillation of a distant electroscope showed retardation of effect? For a believer of Maxwell's theory it was impossible that such a method of proceeding should succeed, owing to the enormous rapidity of electric transmission. It is impossible to observe the excitation of a magnet, the discharge of a Leyden jar, &c., at anything but a moderate distance, say 10 metres. Now, light and electricity, according to the theory, traverse this space in one thirty-millionth of a second. Now, the time necessary for the discharge of a Leyden jar is infinitely short, but short as it is, it is much too long. Nature, however, supplies another method. It has for long been known that on the discharge of a Leyden jar electric oscillations take place. A single vibration can, therefore, be chosen as a sort of unit. Unfortunately, the shortest vibrations observed are of the order of a million a second; therefore the effect of one of these vibrations is propagated to a distance of 300 metres during its existence,

* Abstract of an address to the Congress of German Naturalists, Heidelberg, September, 1889.

Digitized by Google

and it follows that in the restricted space of a laboratory cause and effect will be simultaneous. Another method was, therefore, required, and the obstacle was finally overcome, when it was discovered that not only is a Leyden jar discharge oscillatory, but that oscillations take place in any conductor in the vicinity, and that these oscillations are far more rapid than those of the Leyden jar, being of the order of from 100 to 1,000 million per second. From that time we possessed signals whose duration was comparable with a thirty-millionth of a second, but they would, however, have been of little use to us if we had been unable to seize them, so to speak, only at this distance of about 10 metres. The means we employed were very simple.

At the spot where we wished to observe the signal we placed a conductor—for example, a rectilinear metallic wire, containing a slight interruption; and when the electric field varied rapidly a slight spark appeared at the gap. The sparks are microscopic, hardly the hundredth of a millimetre in length. Their duration is less than a millionth of a second. It seems almost inconceivable that they should be visible, yet they are, in a dark room and to an experienced eye. At the commencement we had a number of questions to solve as to the circumstances under which the vibrations were strongest, the shape to give the conductor, the position to place it in, &c. When these questions were solved the solution of the problem was quite easy.

We observed that at certain points of the room sparking was violent, while at others it was extinguished, and we noticed that places of electric activity and inactivity succeeded each other in regular order, and we were able, therefore, to affirm that the propagation was not instantaneous, and we were able to measure the wave lengths. Were the waves longitudinal or transverse? In reply to this query we placed our wire in two different positions at the same spot. In one it showed electric excitation, in the other not. This decided the question: the waves were transverse. What was the speed of propagation? It was only necessary to multiply the wave length by the duration of the vibration, which we could calculate. We found a velocity approximating that of light. If you contest the exactitude of our calculation, we have another resource. The velocity of electricity in long wires has for long been experimentally determined, and we found that it agreed very well with that obtained by us in these experiments. These experiments, simple as they are, have important bearings: they overthrow the whole theory of action at a distance, and mark the triumph of Maxwell's system.

To those who still doubt I would point out that every effect which is observed with light waves can be observed with these electric waves. If the conductor is placed in the focus of a large concave mirror, the electric waves unite and leave the mirror in the form of a rectilinear pencil. By turning this mirror we can send the ray in a different direction. When we interpose in its path conducting bodies, the electric ray is stopped, but not destroyed, since it is reflected. To study the refraction of light we employ a prism. The same can be done for electricity, only the dimensions of the waves and of the ray oblige us to use as a conductor a very large prism. Moreover, it is necessary to choose a cheap substance, such as pitch or asphalte. Finally, it is possible to observe with the electric ray phenomena which up to the present have only been observed in the case of light, namely, those of polarisation.

But enough of experiments. In future we must not speak of currents traversing conductors: we must speak only of undulations crossing space, separating, assisting each other, or reinforcing each other. The domain of optics is no longer limited to undulations only a fraction of a millimetre in length: it comprises waves whose length may be measured in decimetres, metres, and kilometres. From now electricity will be seen in many places where it was not previously suspected. The domain of electricity extends over the whole of Nature. But there are questions behind which still remain unsolved—the questions of the nature and property of matter, of the ether, its structure, movements, and limits. Still further behind this is the question of weight and inertia. Physicists of ancient days decided that everything was made of fire or water. Before long the modern physicist will ask if all existing things are not modifications of the ether. That is the final goal of modern science. Shall we ever attain it? To that question I can give no answer; but we have got to a higher point than we have ever attained before, and the road is not too steep, and the next stage is not inaccessible. Numerous ardent spirits are pushing their investigations, and we can await with confidence the result of the searches which are being made in this direction.

Exeter.—The Exeter Electric Light Company ran their arc lamps on Monday last for the first time. Amongst the buildings lighted by arc lamps is the St. Sidwell's Church. The lights at the theatre have lately been running much more satisfactorily.

LONDON CHAMBER OF COMMERCE.

Special Meeting of the Electrical Trades Section.

A special meeting of the Electrical Trades Section of the London Chamber of Commerce was held on Monday at their offices, Botolph House, Eastcheap, to receive the report of the Committee which was appointed at the meeting on the 28th ult. Mr. R. E. Crompton presided, and among those present were Sir James Anderson, Major Flood Page, Prof. G. Forbes, and Messrs. J. Swinburne, Musgrave Heaphy, J. F. Albright, Stepney Rawson, A. P. Lundberg, A. Le Neve Foster, W. Beaumont, R. S. Erskine, C. J. Wharton, and G. Binswanger. Mr. C. Musgrave, of the London Chamber of Commerce, acted as general secretary at the meeting.

The CHAIRMAN stated that the Committee appointed at the last meeting had met several times, and had prepared a report which Mr. Trotter would read.

Mr. A. P. TROTTER (the Sectional correspondent) read the report, as follows:—

REPORT OF THE SPECIAL COMMITTEE ON THE EDINBURGH EXHIBITION.

At the meeting of the Committee of the Section, which was held on October 28th, the following resolution was proposed by Major FLOOD PAGE, seconded by Mr. SWINBURNE, and carried unanimously:—

Resolution.

"*That with a view of the electrical industry taking common and united action with regard to the proposed Electrical Exhibition in Edinburgh in 1890, a Committee be appointed to consider the conditions on which it may be advisable to take part in the Exhibition, and that a meeting of the Electrical Section of the Chamber be called for Monday, November 11th, to receive the report, and, if thought advisable, to take action thereupon.*"

Your Committee have considered the question referred to them in the above resolution, and have the honour to report as follows:—

1. If the Exhibition Committee in Edinburgh had consulted the electrical trade as to the desirability of holding an Electrical Exhibition in the year 1890, they would probably have received a well-nigh unanimous answer that it was too soon after the Paris Exhibition to serve any useful trade purpose.

2. The opinion of the industry on such a matter can easily be ascertained now that an Electrical Section of the London Chamber of Commerce has been formed, as members from all parts of the kingdom belong to that section.

3. Nevertheless, the Exhibition being in course of organisation, it seems advisable that the trade should not refrain from exhibiting, provided that terms can be obtained from the Exhibition authorities more favourable to the trade than those provided in the regulations which have been issued.

4. It must be clearly understood that this report is not dealing with the question of lighting the Exhibition, for which, of course, the Exhibition authorities must pay in the usual manner; nor with any question involving the purchase or hire of any electrical plant which the Exhibition authorities may require for their own purposes; but simply with the question of exhibitors.

5. The charge for space is to be 2s. 6d. per square foot, the minimum charge being £2. 10s.

We think that the electrical exhibitors should be allowed an agreed-upon space free, and should pay for any additional space they may require.

6. Many of the electrical exhibits, though not intended in any way to light the Exhibition, cannot be properly shown unless they have steam or current supplied. We think that, when steam-power or current is necessary for the proper display of the exhibit, they should be provided by the Exhibition authorities free of cost to the exhibitors.

7. The regulations provide that the exhibitors should furnish all necessary attendants. We recommend that, for electrical exhibits where there is no machinery in motion, the Electrical Section should club together, and appoint and pay for such attendants as they may judge necessary.

8. We think that the Exhibition authorities ought to pay for the insurance of the electrical exhibits.

9. We suggest that there should not be any awards; but if it is determined to have awards, we think that the Council of the Institution of Electrical Engineers and the Electrical Section of the London Chamber of Commerce should recommend the jurymen to the Exhibition authorities.

10. Clause 25 of the regulations is as follows:—"The Executive Council reserve to themselves the right of examining, testing, or analysing any of the exhibits."

Digitized by Google

We do not think that any person whatever except the electrical jury should have the right to test, analyse, or examine (in the sense here meant) any of the electrical exhibits, and we think that any electrical exhibit may be sent without being in competition, and such exhibits should not be tested or analysed even by the jury.

11. In conclusion, although the whole of the electrical trade is now busier than it has ever been, and is certain to be busy all through the year 1890, and much valuable time will be occupied in the preparation for the Edinburgh Exhibition, and although it is not likely that any profit or advantage will accrue to the electrical exhibitors, yet on the whole, as the Queen has given her support to the Exhibition, and Scotland generally seems inclined to do what can be done to make the Exhibition a success, we think that the electrical trade should not "boycott" the Exhibition; but we strongly urge that the permanent Committee of the Section should obtain terms at least as favourable as those indicated above.

12. Your Committee have good reason to believe that well-nigh the entire trade will support such improved and reasonable conditions as we have suggested.

Signed on behalf of the Committee,

ALEX. P. TROTTER, Correspondent.

The CHAIRMAN said that before he called for any resolution to be moved respecting the report, the Committee would be very glad to hear what the trade might have to say on the various points dealt with in it.

In answer to questions the Chairman stated that so far as he was aware, the communications of the Committee had been only with the trade; they had not yet communicated with the Exhibition authorities. Two gentlemen from the Exhibition were at that moment in another room waiting to have an interview with the Committee, but before seeing them the Committee thought it would be best for the members of the Section to make up their minds as to what course should be taken. He presumed that any resolution they might pass at that meeting would only bind those present. A good many of the principal firms, however, were represented on the Committee, and they had received letters from the members of the trade who were unable to attend, and who are all in favour of the project—for instance, Mr. Marshall, Messrs. Mather and Platt, and Mr. Garcke.

Major FLOOD PAGE pointed out that the Special Committee was appointed for the purpose of drawing up a report. They had no power to enter into communications with the Exhibition authorities. That was a matter which would fall to the permanent Committee of the Section. The Section could either adopt or refuse to adopt the report, or part of it, or they could modify it. As soon as that was done the permanent Committee would take up negotiations with the authorities in Edinburgh, based, he supposed, on the report, if the report were approved. He believed it would be quite impossible to bind any trade people. Considering that there were 210 members of the Section the meeting was a small one, but he thought it would have been larger if longer notice could have been given. He thought, however, that the expression of that meeting would carry great weight with it.

Mr. MUSGRAVE HEAPHY quoted paragraph 8 of the report, and said he would rather not express any opinion as to the recommendation that the Exhibition authorities should pay the insurance of the electrical exhibits.

The CHAIRMAN remarked that that was a point upon which they all held a strong opinion, for owing to the bad construction of the buildings at South Kensington, the exhibitors found themselves charged very heavily.

Prof. FORBES said that while the trade would not want a repetition of tests which had been already made, there was a large quantity of electrical machinery which did require tests at the present moment, especially alternating-current machinery. He believed that the Exhibition authorities were thinking of making tests; but it might be a point whether or not the trade should make any representations to them on the subject. In answer to a remark, he added that the deputation that had waited upon the Council of the Institution of Electrical Engineers stated that the Exhibition authorities were quite prepared to go to considerable expense in connection with tests. Many tests were not necessarily required, but he thought that in regard to alternating currents and transformers, tests would be very important.

Major FLOOD PAGE: It depends entirely on who is to make the tests.

Prof. FORBES: Undoubtedly; and the suggestion in your report is a very good one.

Major FLOOD PAGE said that in the report the Committee had suggested that there should be no awards, but that, if awards were made, the Institution of Electrical Engineers and the Electrical Trade Section of the London Chamber of Commerce should be asked to nominate the jury. The value of the awards would depend on who were appointed, and it would also take a long time. The tests went on for nearly three months, he believed, after the Exhibition at the Crystal Palace was closed. It would also involve considerable expenditure. He thought they might take the report as it stood, and consider the suggestion of Prof. Forbes as an additional recommendation; and if that gentleman would assist them in formulating some proposition to the General Committee, it might help the matter forward.

Major FLOOD PAGE then proposed the following resolution:

"That the report of the Special Committee on the Edinburgh Electrical Exhibition be received and adopted, and that the subject be now referred to the Permanent Committee of the Section, with power to negotiate and carry out the necessary arrangements with the Committee of the Edinburgh Electrical Exhibition."

He thought there had been some little misconception as to the duties of the Committee which had made the report. They had really had very little time, and it was necessary that they should have that meeting. In a fortnight, as at present arranged, the entries must go in to the Exhibition. If the meeting passed the resolution he had proposed, it would fall into the hands of the Permanent Committee to enter into negotiations with the Exhibition Committee.

Mr. A. LE NEVE FOSTER seconded the motion, which was adopted.

Mr. ALBRIGHT thought that before seeing the two gentlemen referred to by the Chairman, the meeting should decide as to the question of space which the trade would require at the Exhibition.

Major FLOOD PAGE replied that the question was dealt with in the report. The suggestion, however, of Mr. Albright seemed to him to open up another field of usefulness for the Section. Mr. Kenric Murray (the Secretary of the London Chamber of Commerce) had told him that the West African Section took charge practically of the whole of the West African exhibit at the Colonial Exhibition. The question which arose out of the suggestion of Mr. Albright was whether it would not be an increased advantage for all the exhibitors to exhibit through their Section of the London Chamber of Commerce. One of the rules in connection with the Edinburgh Exhibition was that applicants for space from foreign countries and the Colonies, for which no Commissioner was nominated, must appoint representatives in Scotland. Now, if a Commissioner were nominated, all the entries would go through him, as in the case of the Paris Exhibition. The trade would then secure united action, which they would not get in any other way. At present it was not known what space would be required by the trade, and they therefore had had to make this point vague in the report. He thought if they could arrange to have all the exhibits sent through the Electrical Trades Section of the London Chamber of Commerce it would do a great deal of good.

The CHAIRMAN asked Sir James Anderson if he thought that the telegraph companies would take part to any considerable extent in the Exhibition.

Sir JAMES ANDERSON replied that he had no doubt the telegraph companies would do all they could. He was, however, at a little loss to know what they could show. They had so often taken part in exhibitions. He was at the Paris Exhibition the other day, and he could not find their exhibit, though they had obtained a gold medal for it (laughter). One did not expect an Exhibition so soon after the Paris Exhibition.

The CHAIRMAN: We all feel that. What do you think of treating Scotland as a foreign country, and going under one section?

Sir JAMES ANDERSON: I think you should go under one section, and I do not think Scotland would object to that.

Mr. ALBRIGHT proposed the following resolution:

"That, provided the Edinburgh Exhibition authorities accept the terms as set forth in this day's report, the Electrical Section of the London Chamber of Commerce act generally as Commissioners for the electrical trade at the Edinburgh Exhibition."

Mr. SWINBURNE seconded the motion, which was adopted.

Mr. Lee Bapty, general manager, and Mr. Gaskell Exton, secretary of the London Committee of the Exhibition, were then invited into the meeting, and

The CHAIRMAN gave them a summary of the recommendations contained in the report of the Committee, and mentioned the suggestions which had been made during the meeting.

Mr. LEE BAPTY said he had hoped to have had the opportunity of meeting their Sub-Committee in order to discuss these points before the report had been made to the Committee of the Section, because he had already consulted his Council in Edinburgh, and had been prepared with a certain amount of concession from them, which he had hoped would meet with the views of the Committee. He noticed that the Committee seemed to think that the Exhibition authorities were asking to have the Exhibition lighted for nothing, and that it had been started without consulting the trade in any shape or form. He had only been appointed General Manager of the Exhibition after the whole thing had been decided upon generally, but he had been informed that the project was broached to the electrical and technical press before it was put into a concrete form, and that it had met with their support. The promoters of the scheme in Edinburgh

Digitized by Google

therefore thought they would always have the support of the members of the trade. With respect to the concessions asked for, an objection appeared to have been taken at the last meeting that it was not fair to ask the electrical trade to go to Edinburgh to make money for the promoters of the Exhibition there. Now, that was the last thing the promoters had in view. All that they wanted was to present to their visitors the latest developments of electrical science and industry, and, as a proof of that, he had their authority to offer to all the exhibitors of electrical appliances—all who came with the *cachet* of the Electrical Trades Section of the London Chamber of Commerce—that, after the legal demands were met, any money paid for space by their exhibitors should be returned in full, or as near as the surplus would allow. He hoped that that would meet their views in the matter of having free space, because he thought it was certain that there would be a surplus left. With respect to the payment of insurance, that was a matter that had not cropped up at all, but he would be prepared to ask the Committee of the Exhibition to meet them on that point, which was not a serious matter. It was, however, something that had never been done before.

The CHAIRMAN: The cause of this request is that the exhibitions in London were located in buildings of such a nature that the charges for insurance were very high, and came very heavily on the exhibitors.

Mr. LEE BAPTY stated that at Manchester they had pictures of the value of about £2,500,000, and the insurance was only 7s. 6d. per cent., or 10s. to cover all risks—carriage, breakages, &c.

The CHAIRMAN: If that is so, and you have buildings of that permanent kind, the insurance would not fall so heavily on the exhibitors.

Mr. LEE BAPTY said he did not know how the Exhibition was going to be built, but he believed that at Manchester they reduced the cost of insurance very much by undertaking to pay for efficient watching. He had twenty-four watchmen and six firemen constantly on duty throughout the night, and they never had a single claim during the whole time. With respect to the question of awards, he thought he might say that the Exhibition authorities would leave themselves entirely in the hands of the Trade Committee. As, no doubt, they were aware, the subject was broached at the meeting of the Council of the Institution on the previous Monday, and it appeared to be the feeling then that it would be desirable to have certain trials if the exhibitors wished for them; but he should say that the Exhibition authorities would not be prepared to have trials excepting at the expense of the exhibitors. If exhibitors wished to have trials and competent tests by a technical jury, he thought they would be asked to pay for the charges of the jury. With reference to the regulation quoted in the Committee's report as to the testing, &c., of the exhibits, the rule was not intended to apply to machinery or electrical appliances, but to enable them to reject any intended exhibit which might be dangerous—such as an oil or a spirit. As to the lighting, there had never been any intention on the part of the authorities to ask for the lighting free. They were now preparing specifications for the electric lighting contracts, and they would be sent out in the usual course to all electric lighting firms—those who were prepared to accept such contracts. Steam-power would be provided for the ordinary exhibits. He thought there ought to be no difficulty in finding free current. With reference to the remark about the proposed Exhibition being too soon after the one in Paris, he was afraid it was too late to discuss that matter now, but if the Exhibition authorities had the support of the electrical trade, nothing would be wanting on their part to make the Exhibition a great success. His committee had felt that the improvements in electrical science were sufficient to warrant an Exhibition.

Major FLOOD-PAGE said he thought they might be very much encouraged by what had fallen from Mr. Bapty. One point was of great importance. They were now in the middle of November and the entries would close on December 1st. He supposed the Exhibition authorities would allow the electrical exhibits to be entered until January 1st? He would ask Mr. Bapty formally to consent to that extension, as some time would be required for preparation by those who intended to take part in the Exhibition.

The CHAIRMAN (to Mr. Bapty): I have further to tell you that we cannot take your answer about testing as final. There are some kinds of electrical appliances that would add enormously to the interest of the Exhibition if there were tests. We propose, in the course of a few days, to send you a resolution which we shall draft on the subject; but the pith of it will be that whereas other kinds of machinery have all been tested at other exhibitions, there is one kind that has never been tested—alternating machinery and transformers; and we think it would be a great advantage to the trade, the public, and every one, that a trial should be made, and that that limited amount of testing should be provided by the executive.

Mr. BAPTY supposed that it was only wished to apply the tests in question in cases where the exhibitors voluntarily submitted themselves to the ordeal.

Prof. FORBES stated that when the deputation waited on the Electrical Engineers the other day the question was raised, and it was rather thought that the best plan would be that a selection should be made by competent judges as to what machinery should be tested, assisted by the wishes of the exhibitors.

Mr. BAPTY expressed his obligation to the Committee, and the proceedings then terminated.

BOOKS, &c., RECEIVED.

"Electrical Engineering: Systematically-Arranged Questions on Telegraphy, Telephony, Electric Lighting and Transmission of Power." By Prof. Jamieson, M.I.C.E. (London: Charles Griffin and Co.)

"Potential: Its Application to the Explanation of Electrical Phenomena popularly treated." By Dr. Tumlirz. Translated by D. Robertson, M.A. (London: Rivingtons.)

"Advanced and Honours Questions in Magnetism and Electricity." By Andrew Jamieson, M.I.C.E. (London: Charles Griffin and Co.)

Calendar of the Glasgow and West of Scotland Technical College. Session 1889-90.

"Electric Light and Power Supplies." (The Electrical Supply Co., Chicago.)

Catalogues "A" and "B." (Messrs. Davis and Son, Derby.)

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To night) FRIDAY, November 15th.

PHYSICAL SOCIETY.

5 p.m. Ordinary Meeting. "On Electrification due to the Contact of Gases and Liquids." By J. ENRIGHT. "On the Effect of Repeated Heating and Cooling on the Electrical Resistance and Temperature Coefficient of Annealed Iron." By H. TOMLINSON, F.R.S. "Notes on Geometrical Optics." Part II. By Prof. S. P. THOMPSON, D.Sc.

INSTITUTION OF CIVIL ENGINEERS.

7:30 p.m. Students' Meeting. Paper to be read, "The New Harbour and Breakwater at Boulogne-sur-Mer." By S. C. BAILEY, Stud.Inst.C.E.

MONDAY, November 18th.

LONDON INSTITUTION.

5 p.m. Lecture, "The Phonograph." By Colonel GOURAUD.

TUESDAY, November 19th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be read, "Water-Tube Steam Boilers for Marine Engines." By JOHN J. THORNYCROFT, M.Inst.C.E.

OLD STUDENTS' ASSOCIATION.

8 p.m. General Meeting. Presidential Address: "Some Peculiarities of Alternate Currents." (Illustrated by experiments). By W. E. SUMPNER, D.Sc.

ROYAL VICTORIA HALL.

8:30 p.m. Lecture, "The Forge of the Blacksmith God." By Prof. JUDD.

WEDNESDAY, November 20th.

ROYAL METEOROLOGICAL SOCIETY.

7 p.m. Ordinary Meeting. Papers to be read, "Second Report of the Thunderstorm Committee—Distribution of Thunderstorms over England and Wales, 1871-1887." By WILLIAM MARRIOTT, F.R.Met.Soc. "On the Change of Temperature which Accompanies Thunderstorms in Southern England." By G. M. WHIPPLE, B.Sc., F.R.Met.Soc. "Note on the Appearance of St. Elmo's Fire at Walton-on-the-Naze, September 3, 1889." By W. H. DINES, B.A., F.R.Met.Soc. "Notes on Cirrus Formation." By H. HELM CLAYTON. "A Comparison between the Jordan and the Campbell-Stokes Sunshine Recorders." By F. C. BAYARD, LL.M., F.R.Met.Soc. "Sunshine." By A. B. MACDOWALL. "On Climatological Observations at Ballyboley, county Antrim." By Prof. S. A. HILL, B.Sc., F.R.Met.Soc.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Opening Address by the Duke of ABERCORN, C.B., Chairman of Council, and presentation of prizes.

THURSDAY, November 21st.

LONDON INSTITUTION.

7 p.m. Lecture: "Early Italian Cantatas." By C. HUBERT H. PARRY, M.A., Mus.Doc.

Digitized by Google

The Electrician.

Published every Friday. Price Fourpence; Post Free, Fourpence Halfpenny. Editorial, Publishing and Printing Offices:

No. 1, SALISBURY COURT, FLEET STREET, LONDON, E.C.

Telephone No. 2714. *Telegrams:* "ELECTRICIAN NEWSPAPER, LONDON."

All Communications to be addressed to "THE ELECTRICIAN," *1, Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN."

All letters intended for insertion in "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

'THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. Subscribers should receive their copies by the first post on Friday morning.*

'THE ELECTRICIAN" *is on sale at the railway bookstalls throughout the United Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices as above.*

SPECIAL NOTICE.

Owing to the increase in the number of pages of "THE ELECTRICIAN," in order to partly cover the increased postage, we have been compelled to revise the rates for Foreign Subscriptions, which are now as follows:—

	3 months.	6 months.	12 months
For Foreign Parts and Colonies:—	s. d.	s. d.	s. d.
Within Postal Union	6 6	12 6	24 0
Aden, Borneo, Ceylon, China, India, Japan, Java, Labuan, Mozambique, New Caledonia, Persia, Philippine Islands, Siam, Transvaal, and Zanzibar	7 6	14 6	28 0
The rates for the United Kingdom remain as follows:—	5 0	10 0	19 6

TO ADVERTISERS.

"THE ELECTRICIAN" *offers exceptional advantages to Advertisers.* **It has the largest circulation of any English Electrical paper, and circulates all over the World.**

Particulars relating to Advertisements will be promptly forwarded on application to the office.

TRADE ADVERTISEMENTS *intended for the current issue must be handed in not later than First Post on Thursday morning.*

SMALL PREPAID ADVERTISEMENTS *(for Rates see page xiii.) are accepted up to 4:30 p.m. on Thursday.*

TECHNICAL PRINTING.

"THE ELECTRICIAN" PRINTING AND PUBLISHING COMPANY (LIMITED) *beg to inform Electricians, Electric Light Engineers, &c., that they make a specialty of Technical Printing, and have a Staff thoroughly acquainted with Electro-Technology. They can, therefore, promise Accuracy and Despatch in the Printing of Electrical Catalogues and Electro-Technical Literature generally.*

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.

Royal 8vo.

Early in each year is issued "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK. *The* DIRECTORY *was established in 1883, and the 1889 Edition, which is now on sale, consists of more than 600 pages of printed matter. Every care is taken to make the names and addresses of all persons engaged in the Electrical Industries absolutely accurate. Useful Tables and Electrical Formulæ are given, together with popularly-written Biographical Notices of the leading Electricians, Electrical Engineers, &c., accompanied in many cases by Portraits.*

The issue for 1890, which will be still further enlarged and improved, is in active preparation. New Names and Addresses, Corrections, Advertisements, &c., should be forwarded at once to the Publishing Office, **1,** *Salisbury-court, Fleet-street, London, E.C.*

CONTENTS OF THE CURRENT NUMBER.

NOTES 25
Sir William Thomson's Chain of Electrostatic Voltmeters. By Andrew W. Meikle, M.A. Illustrated. Continued 30
Electric Traction on the Barking Road 31
The Identity of Light and Electricity. By M. H. Hertz 32
London Chamber of Commerce.—Special Meeting of the Electrical Trades Section 33
Books Received 35
Meetings of Scientific Societies ... 35
THE CITY GUILDS AND TECHNICAL EDUCATION 36
The Institution of Electrical Engineers—"The Lighting of the Centennial International Exhibition, Melbourne, 1888 and 1889." By K. L. Murray, C.E. 38
The Short Electric Railway System. Illustrated 40
American Notes 41
Scandinavian Notes 42
CORRESPONDENCE—
The Institution of Electrical Engineers.—"Observer" 43
CORRESPONDENCE—*Continued.*
The Operative Electricians' Union.—"The Chairman of the Meeting on October 26, 1889" 43
The Theory of Accumulators.—Paul Schoop 44
Badt's Handbook of Incandescent Wiring.—C. Frewen Jenkin 45
LEGAL INTELLIGENCE—
Maxim-Weston Electric Company v. Watt 45
United Telephone Company v. Mitchell 45
The Lacassagne-Thiers Arc Lamp. Illustrated 45
PATENT RECORD 46
COMPANIES' MEETINGS, &c.—
The Western and Brazilian Telegraph Company (Ltd.) .. 46
The West India and Panama Telegraph Company (Ltd.) .. 48
Swan United Electric Light Company (Limited) 49
Woodhouse and Rawson United (Limited) 50
New Companies Registered 51
City Notes, &c. 51
Companies' Share List 52

SPECIAL NOTICE.

With the last issue of "THE ELECTRICIAN" was given (gratis) the Index to Volume XXIII. Complaints of non-receipt should be promptly made to "The Publisher."

NOW READY.

Volume XXIII. of "THE ELECTRICIAN," price 12/6, post free, 13/6.

ALSO NOW READY.

Cases for binding Volume XXIII., price 2/0, post free, 2/3.

THE CITY GUILDS AND TECHNICAL EDUCATION.

It is now about twelve years since some of the leading City Companies determined to draw up a scheme for a national system of Technical Education, which was to be started and maintained out of their Corporate funds. A Committee was formed of members of the companies interested, strengthened by the addition of Sir WILLIAM (now Lord) ARMSTRONG, Mr. BARTLEY, Lieutenant-Colonel DONNELLY, Captain DOUGLAS GALTON, Prof. HUXLEY, and Mr. H. TRUEMAN WOOD. The report presented by this Committee embodied a scheme providing for the foundation in London of a central institution for higher technical instruction, for the establishment and assistance of trade schools, and for the conduct of the examinations in technology, which had been established by the Society of Arts in 1876, with the aid of a grant from the Clothmakers' Company. An Association of Livery Companies, for carrying out these objects, was founded in 1878 under the designation of "The City and Guilds of London Institute for the Advancement of Technical Education." A commencement was made very shortly afterwards by the Association taking over the conduct of the Technological Examinations, and by the appointment of Professors AYRTON and ARMSTRONG to give courses of evening lectures in physics and chemistry respectively, with special regard to their appli-

Digitized by Google

cation to various industries; and these courses, which were first held at the Cowper-street Middle Class Schools, were extended two years later by the appointment of Prof. PERRY to lecture on Mathematics and Engineering. In the same year Mr. (now Sir PHILIP) MAGNUS was appointed Organising Director of the Institute and Secretary to the Council, and in 1883 the classes were transferred to the Finsbury Technical College, which had been specially built for the purpose.

The Finsbury College was intended to provide technical instruction mainly for artisans, of such a kind as to develop their intelligence, and to fit them by so doing and by training them in the scientific principles underlying their work, to improve the methods of manufacture adopted in the trades in which they are engaged, and so effect something towards enabling British workmen to compete with those of other nations under less disadvantageous conditions. Very soon after the opening of the Finsbury College classes were formed for giving special instruction in applied art and in the manipulative details of various trades. These classes have, no doubt, been of considerable assistance to a large number of artisans, who by that means have been enabled to acquire a more thorough knowledge of their trade, and thereby to earn increased wages. It would, however, be nothing less than a disaster if the result were to drive into the background the primary object of the College: to provide workmen with a training adapted to enable them to occupy positions as foremen of works, not merely to their own advantage, but to that of the industry in which they are engaged. That this is not by any means an imaginary danger is clearly shown by some recent press criticisms on the work of the Institute, and by the position taken up with respect to it by several of the members of the City Corporation. To a superficial observer, the trade classes appear to form the most important portion of the work of the Finsbury College, simply because of the large numbers attending them, attracted by the prospect of obtaining higher wages. It is necessary, therefore, to insist strongly on the fact that what these classes do is simply to teach workmen what they ought to have learned during their apprenticeships, and that however much benefit they may be to individual artisans, their usefulness to the nation bears an infinitesimally small ratio to that of educating men capable of introducing new methods and modifying old ones, to the advantage of all who are engaged in the same industry, and therefore to the advantage of the commerce of the country.

An even more important work than the training of intelligent foremen was commenced at the Finsbury College, and transferred to the Central Institution at South Kensington, at its opening in 1884. This consists in the education of mechanical, electrical, and chemical engineers, of so thorough a character as to enable them, after having intelligently gone through the College course, and afterwards obtained a knowledge of the commercial aspects of the industries severally selected by them, to take the lead in the development on scientific—that is to say, on truly practical, lines of the engineering industries of the country. The value of work of this kind is not to be measured merely by the numbers who are trained in this manner—and, indeed, it would not be advisable to turn out men of this kind in any very large numbers, for the simple reason that it would be impossible to find places for them all; and, therefore, as the number of applicants increase beyond what are required, it will be advisable to increase the severity with which the comparatively idle or incompetent are weeded out, so that the advantages offered by the Institution, which is beyond comparison the most fully equipped and the most efficient engineering College in the country, may be given to those who are most capable of profiting by them. Although the Central Institution was only four years old last July, 82 students had attended complete courses of instruction during the preceding session, and 42 had been studying special subjects under the regulation which provides for the admission of students desirous of studying some special branch to the courses of lectures which they require, or to the laboratories, subject to the condition that they shall satisfy the professor at the head of the department in which they wish to study of their having the preliminary knowledge requisite to enable them to profit by the permission. The session which has just commenced shows a still further increase.

In addition to the main work of the Central Institution, most valuable though unobtrusive service is being done to the general cause of Technical Education by the Summer Courses of Lectures given by the Professors and other eminent specialists to the science teachers throughout the country, and 226 students attended these courses during the past session. One of our daily contemporaries recently objected to the fees charged to the regular students of the Institution (£25 to matriculated, and £30 to unmatriculated students) as being too high, and precluding many of those for whom its advantages were intended of availing themselves of them. We, on the other hand, are inclined to agree with the majority of those who send their sons there, and who are almost unanimous in their wonder at the extreme lowness of the fees compared with those which they would have to pay for from three to five years, if their sons were apprenticed to an engineering firm; and students after leaving the Institution, except in cases of exceptional ability, usually find that they have to pay more for their final year, spent in an engineer's workshops, than for their three years at the Institution. On the other hand, the scheme of the Institute provides means by which the poorest, if of sufficient ability, may avail themselves of its advantages, for scholarships tenable at the Finsbury College are offered to meritorious candidates from the Board Schools; and the best of these candidates can afterwards proceed to the Central Institution by means of special scholarships, besides having the chance of competing for open scholarships of greater value.

The work which we have briefly sketched out as being done by the Technical Institute is one of such vast importance to the country, that it is of the utmost importance that it should not be crippled for want of funds, and, therefore, while we are grateful to the City Companies for what they have already done, we would urge them not only to continue their good work, but to do still more than they are doing at present. When the Institute was first founded, it was proposed that all moneys voted by the different Companies should be placed unreservedly at the disposal of the Council, and this was carried out for some years with very great advantage to the cause of technical education. Unfortunately, however, within the past few years several of the Companies, instead of paying their subscriptions into the general fund, have preferred to devote them to the foundation and maintenance of special institutions under their own immediate control. This course has, no doubt, the advantage to the individual Company of producing a more immediate show for the money, but in view of the very great importance of the subject, and of the undeniable fact that incomparably greater good can be done by united efforts than by each Company carrying out its own ideas on its own plan, we trust that public opinion may be directed to the matter, and due credit given to the Companies who have thought more of conferring a lasting benefit on the country than of how much display they could obtain for a given expenditure. And we should at the same time like to see pressure brought to bear on those who have been less disinterested, so that they may be impelled to go and do likewise.

Digitized by Google

THE INSTITUTION OF ELECTRICAL ENGINEERS.

"The Lighting of the Centennial International Exhibition, Melbourne, 1888 and 1889."*

BY K. L. MURRAY, C.E.

In November, 1887, the Executive Commissioners of the Centennial Exhibition, which it had been decided to hold in Melbourne in the following year, consulted me as to the practicability, electrically and commercially, of using electricity as a means of lighting the Exhibition, and I felt that I could assure them that the electric light was the only one which could be depended on to efficiently illuminate the buildings and exhibits, and that its cost would not render its use prohibitive. I recommended dividing the buildings into three sections, and calling for separate tenders for supplying and maintaining the dynamo machines and lamps necessary to light each part, tenderers being requested also to submit an alternative offer for the whole lighting required. My desire was to have each section lighted by a different section, if possible. Finally, I was entrusted with the duty of drawing up a specification, and tenders were invited. Those received all named such a high price for the work that I could not recommend the acceptance of any; but being requested by the Exhibition Commissioners to arrange with one or more of the firms which tendered, I was able eventually to do so, and a contract was entered into with the Australasian Electric Light, Power, and Storage Company for the lighting of the greater portion of the Exhibition buildings, and an agreement was made with Messrs. Ganz and Co. to supply a transformer plant and light the Armament Court, the official reception and dining rooms, and offices.

The Australasian Company's contract was to supply, fit up, and maintain 825 Brush arc lamps, 37 Brush arc dynamos, 7 Brush Victoria dynamos, compound-wound, and 2,000 incandescent lamps, with all requisite switches and fittings. The whole of the machinery and other apparatus was to be of the latest pattern and best workmanship. As usual in such cases, the buildings were ultimately extended considerably beyond the limits originally laid down. The lighting plant had, of course, to be increased proportionately, so that the apparatus actually supplied by the Australasian Company consisted of as under:—

40 Brush arc dynamos, known as No. 7*l*, each capable of giving a current of 10 amperes to from 23 to 25 arc lamps in series.

1 Brush arc dynamo, knows as No. 8*l*, professedly capable of giving current to 55 arc lamps in series.

1 Brush arc dynamo with cast-iron armature, known as No. 6, supplying current of 20 amperes for 5 arc lamps.

7 Brush Victoria dynamos for incandescent lighting, compound-wound for 110 volts at terminals.

937 sixteen-hour round-type Brush arc lamps, with alabastrine globes; 5 Brockie-Pell 20-ampere arc lamps for lighting the dome; 2 Castle arc lamps.

1,900 Swan lamps of 16 candle-power at 100 volts; 27 "Sunbeam" lamps, of sizes ranging from 200 to 600 candle-power each at 100 volts.

All necessary switches, fuses, and leads, the total length of the latter being over 60 miles.

The 7*l* Brush arc dynamos were of two patterns. 1st, that in which the bed-plate and field-magnet yokes are cast in one piece; the field-magnet cores with pole-pieces being, as usual in this form of machine, of cast iron, fastened to the yokes with bolts. The commutator, brushes, and terminals are mounted on a slab of slate, which is fitted into a recess left for it in the bed-plate casting. The other pattern of arc machine has what may be termed a composite bed-plate, or no bed-plate at all. In these machines the two field-magnet yokes are cast in separate pieces, the cores, with pole-pieces, being, as in the former pattern of machine, bolted to the yokes. The two horse-shoe magnets thus formed are connected by two pieces of railway iron, which constitute whatever of bed-plate the machines have. The commutator brushes and terminals are mounted on a slab of wood fitted between the longitudinal pieces of railway iron. The first class of machine will hereinafter be called "solid frame," the latter "rail-pattern" machines. The majority of the solid-frame machines had previously been used at the Adelaide Exhibition, but were fitted with new laminated armatures for use in Melbourne. The balance were sent out direct from England. The framework of the 8*l* dynamo was imported, but the laminated armature was made and all coils were wound in the Australasian Electric Company's workshops, Melbourne. This dynamo was of the solid-frame type. The No. 6 dynamo was also of the solid-frame type, but had a cast-iron armature. Its coils were arranged for a current of 20 amperes. Two types of laminated armature were supplied with the No. 7*l* dynamos—one having plates ·05 of an inch in thickness, the plates of the other being only ·022 of an inch thick. The former I will call thick, and the latter thin plate armatures. The dynamos for incandescent lighting, seven in number, were of the Brush Victoria pattern known as No. E2. The nominal output is stated to be 366 64-watt lamps at an average armature speed of 720 revolutions per minute. The machines were of the newest type, and had very massive magnetic circuits throughout. The armatures are wound with only three layers of rectangular wire, each section consisting of three convolutions. The laminated iron core in the V spaces between the windings is not covered with insulation, so that in these parts it is directly exposed to the cooling influence of the air. The arc lamps were of the well-known Brush 16-hour round type, wound with the low-resistance shunt recently adopted by the makers. Alabastrine globes were used.

In the main annexes the arc lamps were arranged in a double row down each bay, one lamp being allowed for about every 1,200 square feet of floor space. The bays were about 50ft. wide, and the distance between the two rows of lamps was about 25ft., the height of the globe from the floor being about 22ft. Incandescent lamps of 16 candle-power at 100 volts, to the number of about 1,900, were used for illuminating the picture galleries, beneath the galleries, in the aquarium, and in the cellars. The concert hall was lighted by 25 "Sunbeam" lamps of from 200 to 600 nominal candle-power. The incandescent lamps in the picture galleries were set in a single row, 9in. apart, on reflecting frames, the reflecting surfaces of which were painted a dead white. These frames were about 18in. wide, made of sheet metal. Below the lamp another reflector was placed, the primary object of which was to shade the eye from the direct glare of the lamps and keep the floor comparatively dark. With the above arrangement of reflecting frames the walls were the only portions of the galleries illuminated by the direct light from the lamps, and the total absence of glare allowed of a very pleasant rest for the eyes. The switch-board for the arc circuits consisted of two parallel rails of wood, on which ordinary double brass binding screw terminals were fixed. The screws on the lower rail were connected to the dynamo terminals, while those on the upper rail formed the terminals of the various lamp circuits. The positive terminals of all machines and circuits were at one end of their respective rails, and the negative terminals at the other. The connection between the dynamo and circuit terminals was effected by means of short lengths of well-insulated cable. The incandescent switch-board was mounted on a well-finished cedar stand. It consisted of two large slabs of black enamelled slate, on which the nickelled switches and terminals were fastened. Between the two slabs of slate a suitable recess was formed in the woodwork for the reception of a Cardew voltmeter (Goolden and Trotter's make). In the centre of a cedar panel below the voltmeter a small switch was placed, by which any one of the machines could be connected to the voltmeter by turning a handle. Suitable terminals were provided for the introduction of safety fuses, and also for enabling the machines to be coupled in parallel. When so coupled any one or more machines or circuits could be switched on or off without affecting the rest.

The arc circuits mainly consisted of 7/16s stranded cable, nigrite and tape insulated, all other being of the same size of cable, but insulated with rubber and braided. The leads were so arranged that between every two lamps getting current from the same dynamo, there were at least two lamps getting their current from some other dynamos: my object being to make certain that the building should be fairly well lighted, even if several dynamos broke down at the same time. All leads and returns ran in one direction from the dynamo room to the main buildings. But on entering these buildings the leads and returns were taken in totally different directions to the terminal lamps of their respective circuits. By this means, and careful attention to the arrangement of the circuits, the leads and returns never approached each other, except in the dynamo room. Consequently, short-circuiting in the buildings was almost impossible. The lamp circuits were run on the woodwork which carried the roof. The lamps were suspended by cords, so that they could be lowered for carboning or other purpose. The wires from the lamp terminals were taken up the suspending cord and lashed to it at a point a few inches from the pulley when the lamp was at its proper height. They were then taken to the woodwork and fastened to it at such a height that the length of wire forming the cord, together with that from the point of lashing to the suspending rope, was at least equal to the height above the floor at which the wires were fastened. This method permitted the lamps to be lowered to the floor, and at the same time left no cable hanging in festoons about the building when the lamps were in their lighting position. From the terminal lamp of each circuit the wires were taken down the wooden pillars which supported the roof, through the floor, and (bracketed to the flooring joists) to the dynamo room. The incandescent circuits were arranged for a loss of potential of 10 volts. The installation was looked upon as being of a temporary character, consequently the electrical loss was considered to be of less moment than incurring a larger first outlay for heavier leads. Even with the above-named loss the leads

* Paper read before the Institution of Electrical Engineers, November 14, 1889.

Digitized by Google

for a portion of the distance consisted of two cables, each containing 37/14s; and for the remainder of the distance to the point of distribution one cable of the same size was used. The distribution was effected by means of 7/16s cable, and finally by single wire. All cables were insulated to 150 megohms per mile.

The steam was generated in 12 multitubular boilers, the pressure being maintained at 120lb. per square inch. Three pairs of high-pressure engines were used, having cylinders 20in. in diameter, with a 40in. stroke. Normal speed, 80 revolutions per minute; and the total indicated horse-power with full working load was about 1,580. These engines were made in Melbourne, and were similar to those used for working the cable street tramways. I may say here that, recognising the very great importance of having the very best driving machinery, I urged the Exhibition Commissioners to send to England for engines specially constructed for electric light work. It was found, however, that time would not permit of this, and an order was given to a firm of local manufacturers who had engines partly made, and could guarantee, therefore, to have them ready in time. The countershaft was in one continuous line, and measured 202ft. 6in. over all. It was driven by ropes from the engine fly-wheels, in the face of each of which 13 grooves were formed for the reception of the ropes. The shaft was in three equal sections, one for each pair of engines. These sections were connected by movable clutches, so that they could run either separately or together, as required. To reduce to the lowest degree possible the inconvenience which would result if a pair of engines broke down, the dynamos driven by each section supplied current to lamps distributed over the whole buildings; so that if one-third of the light were taken off, no part of the Exhibition would be left in darkness. The main body of the shaft was 6¼in. in diameter, but the size was increased to 7½in. where the three-rope drums were fitted. The normal speed of the countershaft was 190 revolutions per minute. The dynamos were arranged in a double row on each side of the countershaft, the distances between the centre of the countershaft and spindles of dynamos being 28ft. and 33ft. respectively. At one end of the countershaft an automatic speed-recorder was placed. This recorder was essentially a chronograph, and consisted of a drum on which a sheet of paper could be fastened: the drum was driven by a tangent screw working in a worm wheel, which latter could be made fast to or released from the drum spindle by means of a friction clutch. The tangent screw was connected by a flexible coupling to the end of the countershaft. A small table was arranged, having a motion parallel to the drum axis. On the table an electro-magnet was fixed, the movable armature of which carried a small glass pen. The electro-magnet was put in circuit with a battery and clock having a minute contact. As the drum was mechanically driven (without slip) from the countershaft, its circumferential velocity was proportional to the speed of the shaft; and as the clock marked equal intervals of time on the paper, the distances between these marks gave the number of revolutions of the countershaft when measured on a suitable scale. The dimensions were adjusted so that the drum made one complete revolution in five minutes when the countershaft was running at the normal speed. Hence, if the speed were normal and without variation, the marks made by the clock would be in a straight line across the paper. If the speed did not vary, but was either greater or less than the normal, the clock marks would still be in straight lines, though making different angles with the edge of the sheet of paper. An irregular speed would show an irregular line. Geared from the same spindle that drove the reading drum, and mounted on the same base, was a small centrifugal governor. The opening or closing of the balls brought a small contact lever against either one or the other of two contact stops. Two incandescent lamps, one plain, the other coloured red, were hung over the engines, the position of the contact lever determining which, if either, of the lamps should be alight. At the normal speed neither would show light, but a variation of about half per cent. on either side would place one or other of the lamps in circuit. The majority of the diagrams taken by the recorder showed a gradual increase in the speed of the countershaft as the evening advanced. This fact will be referred to later on.

Generally speaking, the lighting throughout the term of the Exhibition was satisfactory. On three or four occasions only did anything occur which would lead the public to suspect that matters were not exactly as they should be. This comparative freedom from inconvenience through irregularities in the lighting was the result of the arrangement of the circuits rather than the constancy of supply to any one circuit.

The boilers, which were designed by a Victorian railway engineer, and built in Melbourne, behaved admirably, though working considerably beyond their proper capacity. The steam pressure was kept extremely regular, the maximum variation seldom exceeding two pounds per square inch for the whole evening's run. The fuel was coke, with a little coal added at times when difficulty was experienced in maintaining the full working pressure required. Notwithstanding the very regular steam pressure, the speed of the engines varied considerably, even though they were fitted with mechanism outwardly resembling Hartnel's automatic expansion gear. With the full load on the countershaft, and the engines indicating about 1,500 horse-power, a single dynamo thrown off or on produced a very sensible alteration in the speed of the rest of the machinery—sufficient, indeed, to necessitate the adjustment of the rheostat controlling the potential difference at the incandescence mains, and to show itself at the speed-indicating lamps. One evening some trials were made to ascertain the effect of an alteration in the steam pressure on the speed of the engines. For this purpose the pressure was altered one or two pounds every half-hour; and it was found that a variation in pressure of one pound per square inch produced an alteration in the speed of the engines of about a revolution per minute, all other conditions remaining the same. The cause of trouble was clearly enough in the governor, and I experienced a great deal of anxiety and annoyance from a fault which should not have existed. The fact is, the makers of the engines could not be made to understand the immense importance in electric lighting of absolute steadiness in the running of the engines, or that there was any difference in the driving of dynamo machines and street tramways.

The Brush Victoria dynamos ran very well through the whole six months the Exhibition was open. In the main they kept cool, though occasionally the thrust bearings showed an inclination to heat. The commutators ran with very little sparking when the brushes were properly adjusted.

Unfortunately, the above satisfactory remarks cannot be repeated with reference to the arc dynamos. In the first place, the insulation in many of them was defective or insufficient. Consequently, "electrical fireworks" formed a not unimportant part of the evening's proceedings, till such time as the faulty armatures and field coils had either been rewound or weeded out. In many cases, the machines ran for several weeks without giving any indications of weakness, when suddenly a breakdown in the insulation would take place. Another fault, more serious (if possible) than the last, existed in some of the armatures, namely, those which have been designated "thin-plate armatures." All the laminated armatures supplied, both thick and thin plate, were built up of the so-called H pieces, bound in with a strip of sheet iron, equal in width to the intended thickness of the bobbin core. There was no indication of the H pieces having been passed between rollers, or anything done to give them the same curvature as the armature. The horns of the H pieces were practically flat, hence their resistance to bending was simply that due to the thickness of the metal, which is insufficient in the case of the thin-plate armatures. A few weeks after the opening of the Exhibition several of the thin-plate armatures threw out plates. Two of these plates struck a door-post, and gave unmistakable evidence of the velocity with which they are thrown. On subsequent occasions the plates were not so neatly thrown out, but were caught by the field-magnets, and cut the insulation of the armature coils. By the time the Exhibition closed a goodly number of plates had been thrown out. To prevent accidents perforated zinc screens were placed over the armatures. The cause of these plates breaking off was evidently the continual bending to which they were subjected in passing through the different parts of the magnetic field in which they rotated. The force due to the rotation of the armature tends to bend the plates outwards, while that due to the attraction of the pole-pieces has the opposite tendency (at least with reference to the outer plates). Clearly, then, though the force due to rotation is constant, as the plates pass through a magnetic field which is not uniform in intensity or direction with reference to any given armature radius, the force tending to bend the plates inwards must vary in different parts of the field, and a constant bending of the plates must result. This mechanical fault was a very serious one, and might have caused damage to life and limb.

Before describing the methods used and tests made with the dynamo machines, it may not be out of place to give a few of the reasons which led to the selection of the method adopted. In order that the tests should be equally satisfactory to all concerned, it was essential that the machines should be tested under the actual working conditions, or while they were at work on their respective circuits. It was not thought to be important that all measurements taken should be of the highest degree of accuracy. As practical engineers know, the conditions of running do not remain constant (especially in arc machines) for many consecutive moments, and the fluctuations which take place affect all data, and the resulting efficiency from instant to instant. Hence the desire was to make tests which would be of practical rather than theoretical value. The many more recently suggested methods of testing dynamos in which all the measurements taken are electrical, such as Cardew's and Swinburne's, or in which the mechanical is the smaller part, such as Dr. Hopkinson's, were carefully considered with reference to the special form of machine to be tested. Of these methods, that of Captain Cardew seemed to be the only one that would give satisfactory results, for by it the machines can be tested under the actual conditions of working. Now that it is no longer thought that a dynamo is simply a generator of electricity,

Digitized by Google

and as such may be used indiscriminately for any purpose to which electricity is applied, makers designing special forms of machine to meet the different requirements for which they are to be used, the importance of considering the behaviour of the machine when working under the exact conditions for which it was designed cannot be over-estimated. In considering the matter, the many advantages, from a mathematical standpoint, of selecting one of the above-mentioned methods, or of running the machine on a closed metallic circuit, could not be overlooked. How much more satisfactory it would be to have the current almost absolutely steady, without those fluctuations caused by a faulty lamp or a bad carbon, which make the readings of the instrument used in testing so irregular and so difficult to obtain with any degree of accuracy! But the machines were not made to run on closed metallic circuit, and if they are to be tested fairly, must be tested with all the fluctuations of current, friction caused by pull of belt on bearings, and other modifying influences which exist under the normal condition of working. In some classes of machine, where the commutator has many segments, and each section of the armature winding has but few convolutions, especially if the machine is intended to light incandescent lamps or charge secondary batteries, the chances of error in any of the above methods would be a minimum. But with machines like the Brush arc dynamos, where the commutator segments are few, and the number of windings per armature coil very great, the errors introduced by running the machine on closed metallic circuit instead of the ordinary lamp circuit for which it was designed may be considerable, unless the metallic circuit is arranged to have the same self-induction as the lamp circuit. With such machines as the Brush the current should be maintained as nearly as possible at the value for which the machine was designed, as small alterations in the current may produce sensible alterations in the behaviour of the machine. The tests should be made when the machines have attained their state of steady temperature. It is, of course, needless to insist that the machine shall on each and every day reach its state of steady temperature, as the atmospheric temperature may vary considerably. It is sufficient if the machine attains a temperature which would be its steady state with some known atmospheric temperature within the range of practical work. If Dr. Hopkinson's method, where two similar machines have their armatures rigidly connected, were used, it would be needful to consider the exact relative angular position of the corresponding coils in the two armatures. If this were not attended to, the armatures might be so connected that the periodic fluctuations of the current would be either increased or diminished by the combination of the machines; hence the conditions of practical work might not be attained. In any case, with the two machines directly coupled (electrically), as suggested either by Hopkinson or Swinburne, the modifying effect of the self-induction of the circuit on the current fluctuation would be lost. For these and other reasons the elegant methods adopted by Hopkinson and Swinburne were deemed unsuitable in this particular case. Cardew's method was also rejected as being unwieldy, necessitating as it does the removal of the machines, and so many belt transmissions. As no other purely electrical method was thought of, it was determined to adopt the method involving the use of a mechanical dynamometer for measuring the energy absorbed by the machine, and to measure the output by the ordinary electrical method. The chief disadvantage of this plan appeared to be in the necessity of having all the instruments used accurately calibrated. The efficiency would not be the ratio of two sets of measurements taken by the same instrument, or even by two different sets of instruments which could be directly compared *inter se*. But as there is no great difficulty in the calibration of electrical instruments, at least within a degree of accuracy sufficient for all practical purposes, and the mechanical dynamometer can be directly tested, the increased facilities for testing the machines whilst actually working on their respective circuits was considered sufficient to outweigh the disadvantages of the method.

(To be continued.)

THE SHORT ELECTRIC RAILWAY SYSTEM.*

As the result of considerable work in elaborating his system, Mr. Short has finally succeeded in devising a complete arrangement for operating street railway cars, and the Brush Electric Company, of Cleveland, have undertaken the exploitation of the same through the Short Electric Railway Company, with a result that there are several roads in operation on the Short system, among them those at Columbus, O.; St. Louis, Mo.; Huntington, Va., and Ensign, W. Va. In a new catalogue issued by the Short Electric Railway Company, we gather some interesting details regarding their latest methods of construction and operation on both the parallel and the series system. The roads above-mentioned are all provided with overhead wires, and for this purpose the hangers are provided with clamps, which surround an insulator made of a mixture of hard rubber. Into this insulator there is screwed a pin with a long projection at its lower end, which is grooved at its lower end to receive the trolley wire. A steel clip passes over the trolley wire, and is riveted to the hanger. The clip is let into the trolley wire, which has an offset to receive it, with the result that the surface of the wire is left perfectly smooth for the trolley shoe which passes under it. A special brass connector is also used for joining up the ends of the wire. In order to insure perfect contact at all times between the wire and the trolley, the company have adopted a trolley shoe instead of the usual wheel, which presses upon the under surface of the wire and makes connection between the wire and the motor. The accompanying illustration shows the sliding contact. The trolley shoe is provided with a sole of soft material, which takes the wear, and is easily replaced at a cost of a few cents, and it is estimated that one of these wearing soles will run 1,000 miles without renewal. The spring bar is fixed to the top of the car by a universal joint, which allows the shoe to follow the trolley wire to a height of 22ft., and to a distance of 3ft. on either side of the track. It is claimed that by this method of construction and the application of the sliding shoe, the vibration of the trolley wire is obviated, and that on account of the wear on the shoe, the trolley wire itself remains entirely unaffected. Ordinarily each car is provided with two motors, which are protected from mud and dust by a covering for both sides and bottom. The arrangement is such that any part of the motor may be removed without disturbing any other part, and special care has been taken to avoid the destruction of the armature or magnet coils. An ingenious method of preventing the latter has been adopted, which consists in covering the magnet cores with copper, and also in surrounding the coils entirely with a copper jacket. By this means the extra current produced in the magnet coils on the sudden variation of the current strength is obviated. In order to avoid all noise, a special type of gearing has been adopted. The pinions which mesh with the gears are made of alternate layers of steel and a specially prepared material, which renders the gears strong and at the same time noiseless in operation. In the operation of the system two wires are run overhead, to which the cars are connected in series, the current being kept constant throughout.

Sliding Shoe employed in the Short System of Electric Traction.

The speed and direction of the cars are regulated by shifting the brushes around the commutator, which is performed from both platforms by a single movement of the controlling lever. Where a single overhead wire only is used, as in the parallel system, which is also operated by the Short Company, an additional resistance is placed under the platform of the car, which consists of a plunger of copper and conical-shaped hopper filled with coke or carbon. The plunger is connected with one side of the circuit and the hopper with the other. As the plunger enters the carbon, it decreases the resistance of the circuit until when it touches the bottom the full current is on. By pressing a foot lever the driver can cut off the current from the motor in an instant.

Besides these details of the car, the station arrangements have all been fully worked out, and, as noted above, the system has been in successful operation for some time past.

* From the *Electrical World* of New York.

Digitized by Google

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *November* 2, 1889.

The Electric Situation in New York.—Involved and hopeless as the electric light situation in New York seemed last week, relief has already come. Judge Andrews, of the State Supreme Court, has rendered a decision continuing the injunction which restrains the city from interfering with the wires of the local companies, pending the trial of an action for a permanent injunction. Judge Andrews decides that the companies have a right to maintain their wires overhead until the subways for their accommodation are completed. He fixes the responsibility for the failure to complete the subways on the Subway Company, but intimates that the duty of keeping their wires properly insulated devolves on the plaintiffs, permission to repair old wires and to replace them with new and safe wires being obtainable from the Board of Electrical Control by a mandamus if refused. This decision, therefore, lets daylight in on the darkened situation, and strengthens the position of the companies as to their right to put their overhead conductors in good shape. The coroner's jury, which has been investigating the death of the lineman killed recently, has reported its inability to determine the origin of the fatal current, and recommends, among other things, that the insulation of the overhead wires be improved. It further recommends that a licensing board be appointed by some proper authority, and maintained by the various companies furnishing electricity, which shall grant permits only to men who have proved themselves competent to perform intelligently the duties of linemen. The result of this concurrent action has also been to fortify the local companies, and the result is that several of the new circuits have gone into operation. There is no doubt that the overhead circuits will be much more closely watched and regulated than they have been heretofore, and this in itself will be a great gain.

The National Electric Light Association on the Overhead Wire Question.—This agitation in New York has, of course, had a bad effect throughout the country, in so far as it has caused needless agitation and alarm on the subject of the danger of high-tension currents. In view of the check which might thus be given to the whole electrical business of the country, the executive committee of the National Electric Light Association has held a special meeting in this city during the past week, and has adopted a series of resolutions affirming the possibility of insulating satisfactorily currents of high tension, whether direct or alternating. These resolutions do not, of course, embody any new facts. They really constitute an appeal to the people, and are very much in the nature of a plank in a political platform. As a general thing, there is little need for such expressions of opinion, but as the public have lately been thrown into such a state of doubt and confusion and terror as to electric currents in general, it is well they should thus be made acquainted with the views of a representative body that has some right to be heard on the subject. These resolutions of the National Electric Light Association deal exclusively with the overhead wire question. The members of the Association recognise the fact that they will probably be required to operate more and more of their circuits underground, but the results so far obtained with underground methods have been so unsatisfactory that they do not feel called upon to express even a qualified opinion on such systems.

Mr. Edison on the Overhead Wire Question.—Another utterance on this subject is that from Mr. Edison which finds a place in the November number of the *North American Review*. Mr. Edison there expresses his convictions as to the impropriety of operating high-tension currents, either overhead or underground, while as to alternating currents, he says frankly that if he had his way he would prohibit their use altogether, on account of their deadliness. In connection with this subject, Mr. Edison mentions that when the Edison Company purchased the Zipernowsky-Deri patents for this country, they did so against his protest, and that his views are stated in full on the company's minute book. While according to Mr. Edison the respect that is due to his position, and granting the entire sincerity of his utterances, there are a great many electricians in this country who regret that he should take such a stand. It is impossible now that any man, or body of men, should resist the course of alternating-current development. Joshua may command the sun to stand still, but Mr. Edison is not Joshua.

Electrical Articles in the Magazines.—While mentioning the *North American Review*, I may add that the number this month is a very striking exemplification of the great interest taken by our periodicals in electrical questions generally. In addition to the article by Mr. Edison, there is one by the right honourable gentleman who has been buying Westinghouse apparatus in an underhand way for sale to the State for purposes of electrical execution. A third article of electrical interest in the *North American Review* is that by Dr. Norvin Green, the president of the Western Union Telegraph Company on the question of "Are telegraph rates too high?" Dr. Green says they are not. The accusation that the stock of the Western Union Company is watered he meets squarely by asserting that within the last 24 years the Western Union Company, has spent more than $25,000,000 of its cash earnings and the proceeds of $6,350,000 of bonds in the construction and extension of its lines and the purchase of other telegraph properties, and that during the same period $28,400,000 of its capital stock has been paid for various telegraph systems it has absorbed. The capitalisation as it now stands is not above the cost value of the company's properties, while it has been admitted that the contracts of the company are of greater value than its properties. As to the cost of telegraphing, Dr. Green says, after pointing out how large the mileage is, "To expect this vast system, covering an area of 3,000,000 of square miles, in great part over rough and sparsely settled territory, to be maintained and operated (at a cost for operators and linemen of more than double the rate of salaries paid in any country in Europe) at the same rate of tolls, without regard to territory, that are paid in the smaller countries of Europe is unreasonable and unjust."

The Government Suit Against the American Bell Telephone Company.—It was expected that when a change in the political control of the country came, and President Harrison succeeded President Cleveland, there would be a relaxation of the efforts on the part of the Government to push the suit against the American Bell Telephone Company for obtaining its patents by fraud. Attorney-General Miller, of the present Administration, is quoted, however, as having said that the Government is determined to press to a speedy conclusion, and with all the forces at command, this extraordinary case. It is stated that the work of specially pushing the prosecution has been entrusted to an official to whom has been given full power to use every legal means in urging the suit as fast as possible. The reason for this action on the part of the department of justice it is not very easy to see, and it is very certain that if such be the determination, the Bell Company will resist this unusual kind of onslaught with all the means at their command, even although they have thorough confidence in the strength and righteousness of their cause. The litigation is an interesting one for the public, because everybody sees that a huge prize is at stake, and nearly every telephone subscriber has a dim sort of idea that if the Bell Company were worsted he would get his telephone service somewhat cheaper.

The Study of Electrical Engineering.—The various schools and colleges are paying more attention than ever to the study of electrical engineering, and the reports from all quarters go to show how great is the interest in the subject in educational circles. Columbia College in this city has just begun its new electrical engineering course, and starts with several students. It is the intention of the college to grant the degree of Electrical Engineer for this post-graduate course, which extends over two years, and is devoted solely to electricity; while for the partial course of one year, a simple certificate will be given. Reports from Cornell show that at that seat of learning the subject of electrical engineering is in greater favour than ever. Three years ago the number of students taking up the electrical course in Sibley College, at Cornell, was 59. The total number

Digitized by Google

in this college at the present time is no fewer than 166. If this sort of thing goes on we shall soon have to start an electrical college. It is quite significant that electricity should be the chosen study of so many men at this time, when the many consolidations among the leading companies have tended to throw a good deal of talent on the market, and it shows how thorough is the belief as to the future of electricity and the great opportunities it will afford to qualified men. In point of fact, while there are plenty of men in electrical work in this country to-day, the number of those who have been thoroughly educated for their duties is much too small. There is a superstition here that a college-bred man is apt to be a very useless kind of a creature, but there is a growing perception of the fact that the man who is theoretical as well as practical has, at east, a little the best of it.

Continuous Currents from Alternating Currents. — The problem of obtaining continuous currents from alternating is one that has received not a little attention, and various solutions have been offered on both sides of the Atlantic. Mr. Nikola Tesla has applied himself to the matter, and now offers a simple and ingenious solution. His idea and method consist broadly in directing the waves of an alternating current so as to produce continuous currents by developing in the branches of an alternating-current circuit certain manifestations of energy or active opposite resistances by which the alternating-current waves of opposite sign are diverted through different circuits. Thus the currents of different sign are, so to speak, sifted out: those of one sign passing over one branch, and those of an opposite sign over the other. There may thus be obtained from an alternating current two or more direct currents without the employment of a commutator. Mr. Tesla proposes both electrical and electro-magnetic methods for achieving this result. In the electrical method the device to create an electromotive force counter to the waves of current on one side may, for example, be batteries or continuous-current machines. In the electro-magnetic method, instead of producing the electromotive force in each branch of the circuit, a field of force may be established, and the branches be led through it in such a manner that an active opposition will be developed therein by the passage, or tendency to pass, of the alternations of current. Another purely magnetic method is that wherein Mr. Tesla employs two strong permanent magnets, the armatures of which are built up of thin laminæ of soft iron or steel, the amount of magnetic metal which they contain being so calculated that they will be nearly or fully saturated by the magnets.

The Regulation of Accumulators in Electric Lighting.—At the meeting of the American Institute of Electrical Engineers this week, Mr. G. B. Prescott, jun., the electrician of the Electrical Accumulator Company, read a very able and interesting Paper "On Methods of Regulating Accumulators in Electric Lighting." Mr. Prescott pointed out in his Paper that the modern electrical accumulator was a thoroughly trustworthy piece of apparatus, and that it could be made to play a very important part in supplementing the present methods in use for electric lighting, relieving stations and isolated plants of the necessity of operating continuously throughout the day at a time when the loads would be lightest and the expense correspondingly high. He illustrated and explained methods of applying the accumulator as an adjunct to the two-wire and three-wire systems, and went on to show how counter E.M.F. cells could also be used to replace the present dead resistance pressure equalisers. He dealt also with the arrangement of locating one or more series of cells in sub-stations conveniently placed near centres of current consumption, and brought out very forcibly the various advantages secured from a scientific and systematic manner of employing the cells so as to get out of any plant its full efficiency while it is in actual operation. Some of the methods described by Mr. Prescott are remarkably ingenious, and it would be interesting to know whether they are not merely theoretical, not having yet reached the stage of practical demonstration.

Storage Battery Patent Litigation.—I may mention, by the way, that the Electrical Accumulator Company, whose cells, of course, are alone referred to, has just succeeded in obtaining an injunction against the Fourth Avenue Railroad in this city, which has been using the Julien cell on its storage battery cars. The cells in use having been made under the methods limited to the Electrical Accumulator Company, the judge has granted an injunction preventing the Julien Company from using cells in which the active material has in any way been applied to the plates in the form of a "paint, paste, or cement." The Julien Company have, perforce, been obliged to suspend the running of their cars, which have won no small amount of popular favour. They are now understood to be actively engaged in manufacturing plates in which the active material is applied in the form of powder, and submitted to tremendous pressure. As soon as these plates are ready the cars will be put in operation again.

SCANDINAVIAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

COPENHAGEN, *November* 9, 1889.

During the recent visit to the Castle of Fredensborg of the King and Queen of Denmark a temporary installation of electric light had been arranged at the Castle by Prof. Jurgensen's electrical establishment, Copenhagen. It only comprised the large dome apartment, which was used as a dining room, and where 80 incandescent lamps have been fixed. The effect was very good, and a capital photograph was taken one night of the royal party at dinner.

The firm of Luth and Rosen (Elektriska Bureau), Stockholm, have just about completed the largest private electric light installation in Sweden, viz., at the large woollen works, Malmö. At the Malmö establishment there are 1,735 incandescent lamps of 16 candle-power each, and 8 arc lamps of 800 candle-power each. In the branch establishment at Turnlund are 115 incandescent lamps (16 candle-power) and two arc lamps (800 candle-power). These two installations comprise four dynamos, which require somewhere about 200 horse-power. In order to make gas entirely superfluous, there is a battery of accumulators of 55 elements. Mr. G. Bellander is the engineer for this installation.

The courtyard of the Royal Castle at Stockholm has been lighted by electricity. An arc lamp of 1,400 candle-power has been placed over each of the four gates. The lamps have been delivered by the well-known firm of J. E. Erikson, and the electricity is supplied from the Stockholm Electric Light Company.

In Christiania the question of an electric tramway appears to be advancing. Some gentlemen have been inspecting similar concerns in various countries, and their report is to the effect that electric tramways are both the safest and the cheapest. The result of this favourable report is a considerable enlargement of the original scheme. Also in Stockholm an electric tramway has been under discussion in connection with the projected Exhibition in the year 1892. The site for the Exhibition is some way outside the town, and an electric tramway will probably be erected between these two points.

The question of a large electric central station in Stockholm is apparently advancing, the directors of the Stockholm Gas Works having just applied to the Corporation for 500,000kr., so as to enable them to commence work on the central station, which, when completed, is expected to cost about 1,500,000kr., or rather more than £80,000. The question has been on the *tapis* for some two or three years, and the gas works have once or twice previously submitted proposals to the Corporation for the erection of a central electric station. As soon as the above sum of 500,000kr. has been voted, applications for electric light will be at once invited, which, of course, will serve as a guidance with reference to some of the details of the plan. Electric light is already in somewhat extensive use in Stockholm, there being about 15,000 incandescent lamps, which is about 10 per cent. of the total number of gas flames. Of arc lamps there are about 300, and since 1886 the use of electric light in Stockholm has been doubled. The whole of this light is supplied from comparatively small installations. The gas company is of opinion that if the electric light could be made available for the whole of Stockholm, about 24,000 lamps would be required. If the area were confined to the portion of the town called Nether Norrmalur only, some 13,000 lamps would probably be wanted: this is the handiest district for a central station, a large amount of light being required in it. Nor will there be any difficulties in extending the area, should other portions of the town be desirous of obtaining electric light. It is proposed to charge 4½ öre, or three-fifths of a penny, per hour per 16-candle lamp, with reduction for larger consumers. It may be added as a somewhat curious incident, that the gas works in the same communication to the Corporation, in which they ask for 500,000kr. towards an

Digitized by Google

electric central station, also ask for a similar sum as first instalment towards the erection of new gas works, which, when completed, are calculated to cost 4,956,000kr., or some £275,000.

The large and enterprising General Telephone Company at Stockholm is about to introduce a new arrangement, which will no doubt tend to further increase their already large number of subscribers. The company intends to start a separate class of cheap subscribers, who can have a telephone for an annual subscription of no more than 50kr., or £2. 15s. 6d. These telephones are intended for families and business people in a small way, and the number of conversations is limited to 35 per week. Special arrangements will have to be made at the station for the serving of these cheap subscribers, who will not be served so quickly as ordinary subscribers, and so as to avoid misunderstandings, the names of the former will be printed with a special type in the company's catalogue.

At Drontheim, Norway, a Mr. Schreiber has obtained concession for the erection of an electric central station. There appear to be a good many applications for electric light already. The Frognerkilen Engineering Company, Norway, will supply the machinery, &c.

In Denmark the telephone has come into very general use in a number of rural districts, villages, and small towns; altogether in places where there is not much likelihood of meeting with telephones in England. A number of fishing villages and lifeboat stations have thus been connected, which has proved a great boon. As an example of a small town with exceptional telephonic connection, may be mentioned Lemvig, in Jutland. There are two State telephone lines to two fishing villages, Harboöre and Fjaltring, a salvage telephone line connecting the town with all the lifeboat stations on the west coast of Jutland between Thyborön and Nymindegab, and in addition the town is in telephonic connection with most of the towns in middle Jutland.

The large Houstholm electric lighthouse on the west coast of Jutland was opened a few weeks ago, and has so far worked in the most satisfactory manner. The height of the lighthouse is rather more than 200ft., and the power of the electric light is some 2,000,000 Borcel-light. The magneto-electric machines, of which there are two—the twin principle having been adopted wherever possible—are from the De Meritens' establishment in Paris, and have a capacity of 45 volts and 250 amperes. The lensal arrangement is from Barbier and Co., Paris; its diameter is 182 metres, and the height about three metres. It is divided into thirty sections, and the lamps are self-regulating, and so arranged that they can be changed almost simultaneously. As a reserve there is a powerful paraffin lamp. The lighthouse gives three short flashes every ten seconds. The electric light is also used for lighting the various buildings belonging to the lighthouse, and electricity is used for working the two powerful sirens, which, although at some distance, are connected with the lighthouse.

CORRESPONDENCE.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The discordant note sounded by your correspondent "Telegraphy," amidst the harmony of the recent social gathering, is heard now not for the first time; and as it appears to have awakened some sympathising echoes in your editorial columns, it demands the more serious attention.

Whatever may be said as regards some of the statements in your correspondent's letter, it seems to me that the general drift of his remarks is based upon a misconception, which lies at the root of the whole matter. I refer to the suggestion that the Society of Telegraph Engineers, under its new title and present development, has deviated from the objects of its foundation, and that foreign interests have shouldered the legitimate owners out of their inheritance.

Such a suggestion is at variance with the record of the intentions of the founders, as laid down in the original statutes of 1872, which stands as follows:—

"The Society of Telegraph Engineers is established for the general advancement of electrical and telegraphic science, and more particularly for facilitating the exchange of information and ideas among its members."

It is a significant fact, and one which should not be overlooked, that in stating the objects of their society, its founders placed *the advancement of electrical science* in the front rank. It was an obvious conclusion at that date to couple the word "*telegraphic*" with electrical science, and that a society of practical electricians should adopt the title by which all engineers who then practised electricity called themselves, viz., "telegraph engineers."

But that the telegraph engineers of 1872 had not chosen their profession, intending to confine their attention solely to the practice of telegraphy, is abundantly proved by the sequel. It is only necessary to refer to the list of the first Council of the Society and the roll of original members to realise the fact that the telegraph engineers of 1872 are the electrical engineers of to-day. Here will be found the names of many men, some still with us, and others now passed away, who, then well known in connection with telegraphy, have since been foremost in the development of electric lighting and other branches of electrical engineering. The great manufacturing firms and companies, some of whom even still bear titles specially identifying them with telegraphy, in earlier days devoted their chief attention to the making and laying of telegraph cables. But these same firms have in recent years added electric lighting departments to their business, and now manufacture electrical appliances of all descriptions.

The new title of "Institution of Electrical Engineers" is merely a recognition of the fact, that under the modern developments of electrical science the same objects as were present in the minds of the founders of the Society are not now adequately represented by the title which was formerly appropriate.

For the same reason it would not be adequately carrying out those objects, if a preponderance were given to telegraphy, either in the subjects chosen for discussion, or in the election of members of the Council.

With respect to the former, I am not aware that any complaint has been made that Papers on telegraphy offered for reading at the Society's meetings have been rejected. As regards representation on the Council, if those who are specially connected with telegraphy think they do not obtain their fair share, it would be easy for them to combine in recommending certain candidates to the Council for the next election. This course was, if I remember rightly, suggested by certain speakers on the Council at the discussion which took place on the election day last year, and, if adopted, would no doubt receive proper attention.

Your correspondent concludes his letter with a threat of schism: that he and his *confrères* will withdraw and form a society of their own. I sincerely hope that nothing of the kind will be done. If it is, I am sure telegraphy will suffer by thus lopping itself off from the common stem. The formation of a separate Institution of Mechanical Engineers may, perhaps, be quoted as a precedent and justification for such a course; but any such analogy would be fallacious. A mechanical engineer need not necessarily be very familiar with the other branches of engineering, while with the present case it is wholly different. Electrical science is one, and all its branches are absolutely dependent upon it. The man who desires to be in the front rank in telegraphy must be first of all an electrician. He must keep in touch with the general development of electrical knowledge, or he will be distanced in his own art by men of wider views.

The remedy which may perhaps meet the objects of your correspondent, so far as they appear to be to any extent legitimate, seems to me to lie in another direction. Let all work together to increase the material prosperity of the Institution of Electrical Engineers, and endeavour to hasten the day when they may leave the hospitable roof which has lodged them hitherto, and build suitable premises of their own. It would then be possible to have more frequent meetings, and there might be separate sections, with their own committees, to give special attention to telegraphy and any separate departments which might be found desirable.

By this means, while every separate interest would receive its full share of attention, the unity would be preserved of an institution which has before it a future of inestimable importance.—I am, Sir, &c.,

OBSERVER.

THE OPERATIVE ELECTRICIANS' UNION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: However much you may be personally adverse to the recently-established Amalgamated Union of Electrical Opera-

Digitized by Google

tives, I am sure that you will give publicity to this letter, and so accord fair play to a class of men of whom I think you have gone out of your way to speak in tones of contempt. If your representative had given a faithfully-recorded report of what fell from the lips of the speakers you would scarcely have stated that the objects of the meeting were shrouded in vague uncertainty. The Rules of the Union are in course of formation, and when they are finished I can promise, as Chairman of the Sub-Committee appointed to draw them up, that you shall receive a copy immediately. Do you consider the industry an important one or not? If you reply in the affirmative, I would ask if you suppose that the operatives are not as well qualified to estimate the status of their occupation as yourselves? They think that they are, and as a natural sequence set to work to do what every industry of any magnitude at all has done long ago, viz., establish a Trade Union for the protection of their interests. Do not be harsh and cynical, Mr. Editor. Do not regard us as foes until we have evinced some hostility. I can assure the employers, through you, that with the exception of one firm, the men are thoroughly satisfied with the treatment they are receiving from their masters, and all round I meet with unstinted expressions of perfect good-will and contentment. Of course, I except the one firm I have referred to, which shall be nameless; but I will state, *en passant*, that, considering the high position it holds in this industry, I am astonished at hearing such grave charges against it. Our desire is to preserve the quietude of which I have spoken, to band together competent workmen of every branch in the trade, and to ensure for them fair and just wages. The time has long gone by to scoff at the idea of unionism. It has become a necessity and a duty. By our laws no incompetent workman will be eligible for membership, and that, I assume, will be nothing detrimental to the interests of the employer.

I do not presume to give advice to you, Sir, but I venture to suggest that your duty is to endeavour to promote harmony and concord between wage-earner and wage-payer. Dissension germinates spontaneously enough, Heaven knows, without being fostered by extraneous irrigation. You might retaliate by saying, "Why get assistance from extraneous sources—Mr. James Rowlands, M.P., to wit?" No charge of interested selfishness and intentional agitation was ever more groundless than the one made by you against that gentleman. He had no knowledge whatever of the scheme afoot until four days before the meeting of October 26th, at the Albion Hall. The committee had not fixed upon anyone to address the meeting, and I suggested that a labour M.P. should be asked to do so. Mr. Rowlands being member for the next division to that in which the meeting was held, he was singularly acceptable; and no one who heard his speech could have found the slightest flaw in its impartiality and freedom from bias. He is one of the men, Mr. Editor, of whom working men are proud. He belongs to our class, and it is to him and such as him that the elevated position the working classes occupy to-day is due. When you insinuate that the workman is an easily-led creature on account of insufficiently developed powers of discrimination, you are throwing stones in a glass house, assuming that you are writing in the interests of the employers. Were George Stephenson or the late Sir Daniel Gooch, and are Mr. Preece and Mr. Paxman included in your category? Do not blame us, Sir, until we do that which is wrong.—Yours, &c.,

THE CHAIRMAN OF THE MEETING ON OCT. 26, 1889.

November 9, 1889.

THE THEORY OF ACCUMULATORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: At the present time the lead accumulator is the subject of much discussion both in practical and theoretical circles. Everybody who is acquainted with the subject feels that neither has the lead-accumulator reached practical perfection, nor has its working received a proper theoretical explanation. The researches of Ritter, Planté, Faure, Gladstone and Tribe, Fitzgerald, Frankland, and many others, have all been in the same direction, and under the belief that the sulphuric acid in the lead-accumulator is the important thing, there being formed certain kinds of "lead sulphates." But it is already proved that the only chemically-known sulphate of lead is not at all the body which ought to be present in the electrodes of a lead accumulator. The fact that during the charging the specific gravity of the sulphuric acid increases, and decreases during the discharging, has led to the opinion that the active material of the plates absorbs and binds a certain quantity of sulphuric acid during the discharging period. Different people have found different quantities of absorbed sulphuric acid. The sulphuric acid, it was considered, should always be the "electrolyte." Also the lead sulphate itself was considered to be the electrolyte, though it is nearly insoluble in the liquid of the cell and present only in a very small proportion. Some time ago I found that acids other than sulphuric acid will perform the requisite functions in a lead accumulator as well: for example, phosphoric acid. I was also struck by the analogy in charging a palladium accumulator and a lead accumulator. The negative plate in each case takes up hydrogen till the point of saturation is reached. Charged over this point there is still an absorption of hydrogen; but this gas is not kept as good as before, and escapes easier. Such a charged plate (it may be charged in any acid which does not dissolve the material of the plate, or which is not acted upon by the electrolytic hydrogen) is like a zinc-plate, giving an electric current in nearly all solutions used up to now for similar purposes. Of course there must be placed in the electrolytic vessel also a plate or a body for purposes of depolarisation, such as the highly oxydised compounds of lead, manganese, nickel, cobalt. With a diaphragm also liquids like nitric acid, chromic acid, chloride of iron, &c., may be used for depolarisation.

It would seem from these experiments that the charged material of the negative plates in a lead accumulator probably consists of a kind of *amalgam of lead and hydrogen*. With this theory all the troubles of the sulphate-theory disappears. We now see why only a seventh of the "active material" is used for storing the current; why all different systems of accumulators give nearly the same capacity; why the E.M.F. is constantly increasing in charging, and decreasing during discharging; why the specific gravity of the dilute sulphuric acid is altered. The chemistry of the lead accumulator becomes more simple and logical. During charging a certain quantity of water is decomposed, the hydrogen being absorbed by the spongy lead and the oxygen being bound by the lead-oxides, in changing these into a higher oxidised form. (M. Wernike was the first to make researches about this so-called peroxide of lead, and M. Bandsept has called attention to the fact that we know nothing certain about the compounds in the lead accumulators.) The specific gravity of the acid must increase in taking away the water from the solution. During the discharge, water is again formed, the hydrogen of the negative plates combining with oxygen from the highly oxidised positive plate: this water will decrease the specific-gravity of the sulphuric acid. The fact that the resistance of a cell will be altered is clear, because during the discharge the plates would contain at least pure water, if some diffusion had not taken place; and the very important transmission of the ions in the electrolytic fluid would not facilitate the diffusion. A charged negative plate taken out of the protecting dilute acid into the open air soon becomes hot, the hydrogen burning to water with the oxygen of the surrounding air. If this negative plate is again placed in the electrolyte, practically no current will be obtained. (Of course, also, the lead in its very fine divided form will easily take up oxygen, and all the easier since the plate has already got hot by the previous burning of the hydrogen.)

The researches which should be made about accumulators in future should give account of the properties and the proper ways of obtaining *the different amalgams of hydrogen*. It is quite certain that lead is not the only metal which will form hydrogen amalgams. Mercury will do it, also iron; nickel and other metals, which would not give compounds with hydrogen by the ordinary chemical way, would do it electrochemically. The opinion of Dr. Bell in his article about the use of accumulators for the electric propulsion of tram cars (*Electri-*

Digitized by Google

cian, October 18th, p. 609) is also my own—that the accumulator will be an important apparatus in the future, but that the present accumulator must be improved till it is suitable for general practical use.—Yours, &c., PAUL SCHOOP.

BADT'S HANDBOOK OF INCANDESCENT WIRING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: There appears to me to be a serious mistake in the handbook of incandescent wiring by F. B. Badt, a review of which appeared in your number of October 11th.

Rule VII., Chapter XXVII. (p. 49), stands thus:—"Where lamps or groups of lamps are placed at different distances from the dynamo, determine first the proper wire for each lamp or group of lamps if placed on independent circuits starting from the dynamo, then combine all wires running in the same direction."

The size of wire is calculated by Rule VI., a certain loss being assumed in the leads. This rule will, I believe, give incorrect results.

The total loss will always be less than that assumed, while the drop of potential in the leads will be less for the nearer groups and greater for the further groups than that calculated from the assumed loss of power. The first-mentioned error is of little importance, being on the right side, but the second may lead to serious mistakes in calculating the sizes of wires required for distant groups of lamps.

The reason for this may be easily seen if we consider the fall of potential along the different circuits. Let us first suppose that the circuits are all kept separate from each other. Then the fall of potential will be uniform along each pair of leads, and since the total fall is the same, therefore the rate of fall will be different for each pair. If the leads be now joined at the first group of lamps the difference of potential between them formerly existing can no longer continue, and a redistribution of the current in the leads will take place. The result of this will be that the total fall of potential at the first group of lamps will be less than before, but the fall up to this point in the leads for the further groups of lamps will be greater than it was before.

By way of illustration, I have calculated the fall of potential along the leads in the example given on p. 50 to Rule VII. The results are given below:—

	Up to the 1° group of lamps.	Up to the 2° group of lamps.	Up to the 3° group of lamps.
Resistance of leads, ohms.	·0332	·058	·0663
Current, amperes	75·58	49·83	24·72
Drop of volts	2·509	5·4	7·04
Power spent, watts.....	189·6	144·	40·5

Total loss of power is 374 watts instead of 437, which is 5 per cent. on whole power of dynamo. The drop of potential varies from 2·5 to 7, instead of being 5·8, which is 5 per cent. on the total E.M.F. (taken as 115·8) of the dynamo.

In many cases, as will be easily seen, the errors may be much greater than those in this example.—Yours, &c.,

C. FREWEN JENKIN.

Wistaston Manor, Crewe, November 12, 1889.

LEGAL INTELLIGENCE.

Maxim-Weston Electric Company v. Watt.

A motion in this action came on for hearing on Friday before Mr. Justice North, the object being to compel further and better answers from the defendant to certain interrogatories administered by the plaintiffs, having reference to the alleged dealings in the Company's shares by Mr. Watt, and to his having made profits thereby unknown to his co-directors, also to an allegation that he had expended the Company's money and employed the Company's servants and machinery in making experiments with regard to certain patents of which he was the owner, and that he ought to account for the money so expended. The defendant had declined to answer certain interrogatories on the ground that they were immaterial and irrelevant. The motion was argued by Mr. Cozens-Hardy for the liquidator of the Company, and by Mr. Higgins and Mr. Hart for the defendant. In the result, his lordship ordered the defendant to answer four of the interrogatories, but not two others, which, he thought, went further than the plaintiffs were entitled to at the present stage of the proceedings.

The trial of the action to be postponed until ten days after the answers are put in.

United Telephone Company v. Mitchell.

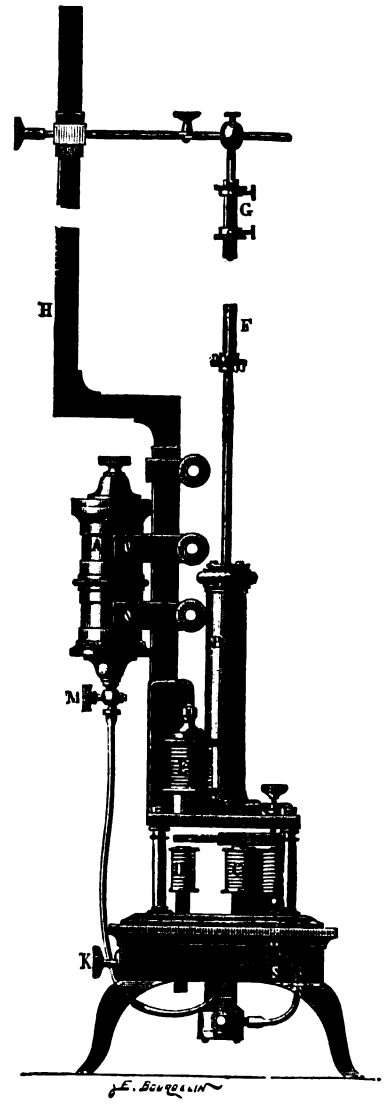
This action came before Mr. Justice Chitty, in the Chancery Division, on Saturday last, on motion for judgment in default of defence.

Mr. MICKLEM stated that the defendant had put in no pleadings. Particulars of breaches of patent had been delivered by the plaintiffs, containing the charges against the defendant. A draft order had now been prepared, which the Court was asked to adopt, in the form made in previous cases of a similar character. Costs, charges, and expenses were asked against the defendant in the matter.

Order accordingly as asked by plantiffs.

THE LACASSAGNE-THIERS ARC LAMP.*

The Lacassagne-Thiers arc lamp was patented in the year 1855, and its interest is therefore mainly historical. Its description is worth giving, however, if only because it works on a principle different to that of other arc lamps, and because it contains a feature since universally adopted, namely, an electro-magnet wound with a high-resistance wire, and placed as a shunt upon the arc.



Referring to the accompanying figure, A is an iron vessel containing mercury; B, an iron cylinder; C, a thick wire electro-magnet; D, a fine wire electro-magnet arranged as a shunt upon the arc; E, a fine wire coil, placed in series with D to increase its resistance; F, the movable negative carbon-holder; G, the positive fixed carbon-holder; H a rod, carrying the cross-piece belonging

* Translated from M. Hippolyte Fontaine's "Éclairage à l'Electricité," by kind permission of the Author.

Digitized by Google

to the positive carbon-holder, and to which the vessel A is attached. M is a cock to which is connected an india-rubber tube terminating in a valve which allows the mercury to penetrate into the cylinder B; K is a screw by which the height of the electro-magnet D can be regulated; S is a tap by means of which the cylinder B can be emptied.

A bar of iron supported on a knife-edge above the electro-magnets C and D oscillates from one side to the other according as the attractive force of one or the other of the magnets preponderates. These oscillations actuate the communication valve: when C preponderates this valve is shut; when D preponderates the valve is open, and the mercury flows into the cylinder, and the piston is forced up. After the lamp has been burning for four hours it is necessary to fill the mercury reservoir and renew the carbons.

The author has seen one of these lamps worked off a battery, and he can assert that no modern lamp gives a steadier arc. Its mechanism is so sensitive that the armature, instead of oscillating, immediately takes up a nearly fixed position, which it maintains until the carbons are consumed, allowing a thin stream of mercury to flow steadily into the cylinder.

Although the Lacassagne-Thier arc lamp has been used in numerous projection experiments both at Paris and Lyons, it has never come into commercial use.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

October 22, 1889.

16,652. W. SHAPLEIGH. London. Improvements in the moulds for casting the plates of secondary or storage batteries.

16,630. E. J. CHAMBERS. London. Improvements in attaching or fastening telpher cables and electric-light cables, telegraph wires, telephone wires, and other cables, wires, and rods to insulators.

16,697. O. T. BLATHY. London. A transformer motor.

16,709. H. H. LAKE. London. Improvements relating to the conversion of alternating into direct electric currents (N. Tesla, United States).

16,710. W. T. GOOLDEN and H. W. RAVENSHAW. London. Improvements in dynamo electrical machines.

October 23, 1889.

16,721. J. FRASER. London. Improvements in and relating to dynamo electric machinery.

16,748. P. M. ALEXANDER. London. Improvements in electrical switches.

16,751. A. VENTRIS. London. An improvement in footway kerbs, with conduits for electrical conductors.

16,755. J. P. REES. London. Improvements in and relating to electric lamps.

October 24, 1889.

16,777. J. G. BRIEN. Sunderland. Improvements relating to switches for use in connection with telephonic apparatus.

16,793. M. RUDDLE. Manchester. Improvements in electric safety fuses.

16,814. H. C. WILLSON. London. Improvements in connectors for drum armatures.

16,816. C. B. HARNESS. London. An improved electro-medical apparatus.

SPECIFICATIONS PUBLISHED.

1888.

10,245. PERRETT. Electrical safety cut-outs. (Price 8d.)

14,843. OULTON and EDMONDSON. Electric meters. (Price 8d.)

14,489. VON MOESE-NOLLENDORF. Electric lighting. (Price 8d.)

14,888. HOLLICK. Electric cranes. (Price 8d.)

15,183. EDWARDS (Cassalette and Kimhardt). Electrical telegraph. (Price 3s.)

15,249. DE FERRANTI. Dynamo-electric machines. (Price 1s. 1d.)

16,249. LUNDBERG. Electric light switch. (Price 8d.)

16,479. LAKE (Walter). Secondary batteries. (Price 8d.)

16,766. SHEPARD. Electric lamps. (Price 8d.)

17,127. CLIFF. Conduits for electric conductors. (Price 4d.)

17,236. DYMOND (Moorthamers). Electric dry piles. (Price 6d.)

17,479. NICHOLSON and JENNINGS. Electric switches. (Price 6d.)

17,537. BAILEY and WARNER. Secondary batteries. (Price 8d.)

17,568. LAURENCE and others. Measuring electric currents. (Price 8d.)

17,590. HOLT. Secondary batteries. (Price 8d.)

17,642. MOSELEY. Galvanic batteries. (Price 6d.)

17,694. HARRIS and GARFORD. Voltaic batteries. (Price 11d.)

COMPANIES' MEETINGS & REPORTS.

The Western and Brazilian Telegraph Company (Limited).

The eighteenth ordinary general meeting of the Western and Brazilian Telegraph Company (Limited), was held at Winchester House, 50, Old Broad-street, on Thursday, November 14, 1889, under the presidency of W. S. Andrews, Esq.

The SECRETARY (Mr. R. M. Cunningham) read the notice convening the meeting, and the minutes of the last meeting, which were confirmed by the present meeting, and signed as correct. The report of the Directors was taken as read.

The CHAIRMAN then addressed the meeting at length, and, in the course of his observations, said: Gentlemen, to-day my task is not quite so satisfactory as it has been on several occasions, because I have a matter to deal with of some considerable importance, and one which is not of an agreeable kind. As we have to deal with the matter at some length, I do not propose to go very fully into the accounts, because they are relatively, under such circumstances, unimportant; and I will, therefore, just touch upon them shortly, and come as quickly as I can to what, no doubt, you are much more anxious to hear about. Now, you will notice that practically the outcome is pretty much what it was at the corresponding period of the previous year. The circumstances, however, are not the same. The first part of the half-year showed a considerable increase of traffic; the last part of the half-year shows a considerable decrease—partly owing to the reduced rates, and partly owing to the interruptions that were sustained by the cables. The difference, however, at the end of the six months only amounts, I think, to some £318. The expenses of the half-year were considerably increased. The item of the London expenses under "C" in the report is practically the same. There are one or two very small increases to deserving clerks, who received a little more pay owing to their greater length of service; but the expenses under "B" for ships and cable are larger—the cable by £2,148, and in the case of the ships the increase is £1,305. That arises in this way: the "Norseman," the Company's vessel, had to be ordered home for new boilers, and it was too dangerous, in our opinion, to leave the service without protection, and we therefore hired and chartered another ship (a 12-knot ship), upon very moderate terms, to take the place of the "Norseman." The "Norseman," therefore, only appeared in the accounts for some three months, and there is a considerable saving —some £2,228—but that is more than balanced by the increased expenses on account of the hired ship, the "Buccaneer," and the total difference, therefore, under abstract "B," is some £2,000 odd. Then we come to Abstract "A," where there is an increase. That arises from an increase in the premiums on the currency. In so far as it arises from that, in the net result it means a great gain, because we, of course, receive a great deal more from the collection than we pay in increased premium; and there is a large balance in our favour under that head. The increase on the coast, and in this abstract "A," is partly occasioned by the prevalence of fever there. The clerks had to be shifted a great deal. One or two of the stations had to be shifted, and we had to provide temporary accommodation. The consequence was that there was an increase of £185 in miscellaneous expenses, £213 in rent and taxes, £215 in travelling expenses, and £257 in medical expenses. I think that comprises all the items that were increased by that cause except salaries and wages, where there is an increase of £925, because we were telegraphed to from our stations abroad to send increased help owing to the need of assistance, and we had necessarily to do so or the system would have been stopped. The items of stores and instruments shows an increase of £700, which means that we have had to increase the things there, and that is not a recurring item. Therefore with respect to many of these items I do not think you will be troubled again—at all events not in the shape of increases. I do not know that there is anything more to say with respect to that part of the business, except that the balance enables us to recommend you to declare a dividend at the rate of 4 per cent., after putting the usual sum to reserve, and to debenture redemption, and carrying over a satisfactory balance. Well, now, gentlemen, I have to deal with the subject of the loop lines, and in connection with that you know that we have always suffered, almost ever since we have been a Company—although we have not suffered from it so materially as we might—from the competition of the Brazilian Government, which has existed, as you know, for many years. Our report will have prepared you for the statement I am now about to make, because we show you there an interchange of certain telegrams, and a decision by the Brazilian Government that we are not to be allowed to lay there loops which you have approved of our laying, and which we conceived to be in the best interests of the service. We do not, of course, pretend to say that we cannot maintain our lines without these loops, because we have always hitherto had to do so; but we do say that if we are allowed to lay them—and we believe we are entitled to lay them—your service will be conducted in the most perfect and efficient way it can be, and we think that that is the way a telegraph service ought to be conducted. Now, the origin of this concern, and of the concessions, dates as far back as 1873. At that time the empire of Brazil was isolated from all telegraphic communication with the rest of the world; her commerce was sustaining a necessary disadvantage, which was sure to accrue from such a state of things; her politics had to be conducted without the assistance of immediate international communication, and her ports were severed from one another; and generally her position was one which a great empire no doubt thought to be practically intolerable. Therefore, at this period of 1873, it was proposed that a concession should be given to establish communication between

Digitized by Google

Brasil and Europe. That concession was opposed at that time by the Director-General of Brazilian Telegraphs, and I may say that the same gentleman is still the Director-General. He appears to have thought that although there were great obstacles to the erection of telegraphs throughout the Empire—namely, that in large districts there were no roads, there were extensive forests, swamps, and rivers—still he thought, I take it, that ultimately he would be able to establish the necessary lines for the accommodation of the Government; but as against that a good many people no doubt saw that that was a work of years. They saw, too, that British capitalists would not invest their money to lay a cable between this country and Brazil unless they could immediately get traffic for it. In the state of the communication at that time no traffic could have been coming forward, and consequently the form that the concession first took was this—that one Company should lay the whole line, not only the line from this country to Pernambuco in Brazil, but also between Pernambuco and all the important ports along the Brazilian coast. The distinguished men at that time at the head of affairs in the Empire of Brazil no doubt thought that that was not too heavy a price to pay to give Brazil some years earlier than she could otherwise have obtained them, the important benefits that would result to her from connections with the telegraphic network of the world. The erection of the Brazilian telegraph system, the internal system, was created—this is my point—for the service of the Government, and for the internal economic government of the country. Ultimately, the form the concession took was that it was divided into two. That was done for the convenience of raising the capital, and the Western and Brazilian Company was empowered to enter into agreements with other companies. Of course that is the Brazilian Submarine Company, because that was the only other Company that there was to enter into an agreement with. The cables were laid, and the Empire was thus placed in direct telegraphic communication with the outer world. The Director-General of Brazilian telegraphs has put us in this—well, impossible position. It seems to me, looking at our concession, that he can only increase the revenues of the State lines by taking the money out of our pockets, and that it is his interest, as a Government officer, to oppose every proposal which would tend to strengthen and improve this Company's communications. You will see, therefore, that that position constitutes a sort of *impasse*. Here is an officer without responsibility, here is a Company with certain concessions; and we say at this point it is for the Ministry to interfere. The Chairman then referred at great length to the communications which have passed between the Company and the Brazilian Government, recapitulating and commenting upon the information given on this point in the report of the Directors. He afterwards read the following "wire" which the Directors sent to their agent in Brazil, dated October 23rd:—"The Directors have reason to believe that the Telegraph Department of Brazil has complained to the Government of the competition of the Western and Brazilian Telegraph Company with the State lines of telegraph. The Board of the Company desire respectfully to point out that the cables of the Company were laid under the concession of April 26, 1873, which provides that the Company shall connect certain ports of the Empire, and which, under Article 4, paragraph 2, says:—'The Government remains perfectly at liberty to establish electric telegraph communications by land in whatsoever direction and to and from such points as it may deem most convenient, and in the mode that may appear to it best administratively, or by means of a private company. But the tariffs of the private telegraph lines which compete with those of this Company shall not be lower than those of the Company;' and Paragraph 3 of the same article says:—'On those portions of the seaboard where there may be, or may hereafter be laid down, land electric wires, in conformity with the foregoing paragraph, the parties who send messages shall be at liberty to transmit their telegrams either through the submarine cables or by the said land lines." Consequently the transmission of messages between the Brazilian ports was not only made a privilege, but an obligation, and so continues during the period of the concession. The Company, of course, could not have established these lines, nor have transmitted these messages, except under the express authority and approval of the Imperial Government. The competition, therefore, and at low rates, has been created, introduced, and continued by the Telegraph Department of Brazil, and the Company respectfully complained from the first, some years back, of this. The Directors are also given to understand that the Telegraph Department complain of the agreement between the Brazilian Submarine Company and this Company, under which they mutually agree to exchange messages not directed to go by other lines; but the first concession, under date March 25, 1870, provided that the whole of the lines as well between Europe and Pernambuco as between Pernambuco and the ports as since connected, were to be laid down and worked by one Company only, consequently no question could possibly arise as to the mutual exchange of messages over a line worked as one system, and any message must have remained on the lines of the Company, whether between Brazilian ports or between those ports and Europe. In place of this concession, and for the purpose of facilitating the raising of the money in England, the cables were divided, and one concession was given for the line, between Europe and Pernambuco, and another for the lines along the coast connecting the ports of Brazil, and these were laid under the mutual agreement to work the lines as one system, and, besides, the Brazilian Submarine Company were authorised, under the existing concession of August 16, 1872 (Clause 23), to make these communications if the concessionaires of the coast line failed to make them, which again shows that the traffic coming to the companies was intended to go throughout over the cables. Without these stipulations no capital could have been secured, all of which was perfectly well known to the Government, and has subsisted ever since. The Company has acted loyally and strictly within its privileges and obligations as approved and imposed by the Government, and respectfully refers the Minister to the official documents cited." On October 28th they also telegraphed to their agent:—"The Board of the Western and Brazilian Telegraph Company have just read in the Brazilian newspapers a copy of the report made by the Director-General of Brazilian Telegraphs to the Government Public Works Department upon the 'insufficiency of present telegraph lines,' *i.e.*, State lines of telegraph. The Director states that the telegraph works with rare perfection, but that the service of paid telegrams is excessively delayed owing to the excessive use of the State lines on the public service, and that merchants consequently use the cables. In other words, the State lines render invaluable service to the Government of Brazil in respect of the economical and efficient government of the country, and thus adequately fulfil the highest purpose of their creation, and thus give a return of the most valuable kind for, and meet the purpose of their erection, but are insufficient for competition for paid messages with the cables. The Director-General further states that additional wires are necessary in view of the international service which the Government undertook, not only in adhering to the St. Petersburg Convention, but also in the competition opened for an American cable. The Directors would respectfully urge that there is no American cable, and that all the obligations of the St. Petersburg Convention are met by the present service. The Director-General then proposes a further expenditure of seven hundred contos, with the object, as appears, mainly of impelling the Government upon the unfair course of an ardent war of competition with the cables with the resources of a powerful State at their back, and places as the first necessity to be provided for the 'international service of telegrams.' The Director-General further states that he has protested against the Company for reductions made step by step, as 'was forced by reductions made in the tariffs of the State lines,' although he thus himself admits that the reductions were forced upon the Company by the reductions initiated on the State lines, and that, consequently, the Company must have followed, or lost—as it did in fact lose—a large part of the business duly authorised by the concession. The Ministry of Public Works appear to have granted the Director-General the credit demanded. The Board of Directors of the Western and Brazilian Telegraph Company, as far as respects the competitive purpose sought to be attained, cannot too strongly protest against this unfair action. On the one hand the Company have so far been refused permission to adopt the best means to work their system the most efficiently, and on the other the Telegraph Department of the Brazilian Government are granted large sums to enable them to enter upon a career of intensified competition, in which the money of the State is to be now specially invested. The Directors venture to hope that the High Imperial Government will reconsider this unparalleled step, and that it may not be irrevocable, as it would constitute a most unfriendly action towards British capitalists, who, confiding in fair treatment by the Government, have invested such large sums in aid of the development of Brazil, and the Directors would further respectfully urge that benevolent consideration should be given to their representations made to the Government." Another important telegram was sent to their agent on November 5th. It was as follows:—"5th.—The Directors of the Western and Brazilian Telegraph Company have been further informed that tenders have been received by the Government for the laying of a cable or cables between Brazil and North America. The Company have already in their message of October 28th drawn the attention of the Imperial Government to the fact that the Imperial Telegraph Department states as the first reason for a further large special expenditure *re* additional wires, 'the American cable and the international traffic,' and this Company is, therefore, driven to conclude that the international traffic alluded to must be that of the Provinces served by this Company, as there is so little other. Under these circumstances, the Company desires respectfully to call the attention of the Imperial Government to Clause 4, paragraph 1, of the Company's concession, which is as follows:—'During such period no other submarine telegraph may be established from any point where the Company may have stations, as indicated in this contract, to any other point similarly circumstanced, throughout the whole extent of the northern and southern lines respectively. This disposition not excluding the Government the power to authorise other undertakings to establish submarine cables communicating between intermediate Provinces of the Empire, provided that such provinces are not included in the number of those which, in accordance with this concession, shall have communication by the telegraph line of the present enterprise.' It is absolutely clear from this Clause that during the existence of the Company's present concession no submarine cable may be allowed to establish communication for messages with the provinces which have communication by the telegraph lines of this Company, and that consequently any concession given to any such company enabling them to compete with the Western and Brazilian Company for messages in the provinces having communication with the line of the Western and Brazilian Company would be an evasion of this Company's concession. The Directors also respectfully point out that Paragraphs 2 and 3 of the same article in no way restrict the above rights, but bear them out, because the public are only given the privilege to send their messages by the submarine cable, or by the said land lines, and there is no right to send them by competing cables. In so far as such American cable may be confined to the service of provinces not served by this Company, this Company's observations do not apply. The Directors desire once more to urge the benevolent consideration of the Company's case upon the Imperial Government." To these telegrams we have had no reply yet. I have now placed our position in this matter before you. It would have been madness for us to attempt to lay these cables. It may be that, when all these thing are carefully considered, it will be seen that the Telegraph Department has not been, under the circumstances, the safest adviser for the Government to listen to. Under any circumstances, we shall continue to urge your case. We got a clause inserted in the agreement we made with the Telegraph Construction and Maintenance Company by which, if we were prevented from laying the cable, we should be free from ordering it, and have no penalties to pay. The Telegraph Construction Company met us very liberally. Our

Digitized by Google

position is financially, you will see, not unsatisfactory, and if we do not lay these cables we shall not have to issue £50,000 of debentures or sell funds out of the reserve. We are not only threatened with the competition of the American cable referred to in the telegram I have read, for there is a proposal to lay a cable from the territory of the Argentine Confederation the whole way to Europe. Before I sit down I think I ought to tell you that although we have maintained our dividend down to June 30th, we are not likely to maintain it this half-year because the revenue is extremely unsatisfactory, and the breaks have been frequent. Of course with regard to this question of the next dividend, something will depend on what the remaining period of the year produces. I might mention that the cause of the interruptions of the cables are, as far as we can see, mechanical. He concluded by moving the adoption of the report and the payment of the dividend mentioned.

Mr. C. W. EARLE seconded the motion.

In the motion which followed, Messrs. W. Griffith, Coppin, Gover, Jackson, and one or two other shareholders took part.

The CHAIRMAN, in replying to one question, stated that their concession had still some 40 years to run. He then put the motion, and declared it carried unanimously.

A vote of thanks to the Chairman and Directors closed the meeting.

West India and Panama Telegraph Company (Limited).

The twenty-fifth ordinary general meeting of the members of this Company was held at Winchester House, Old Broad-street, on Wednesday last, Mr. C. W. Earle in the chair.

The SECRETARY (Mr. R. T. Brown) read the notice calling the meeting and the minutes of the last meeting, which were confirmed. The report of the Directors was taken as read.

The CHAIRMAN: Although a Submarine Telegraph Company only able to show an available balance for distribution at the rate of 3½ per cent. cannot be called a very successful enterprise, I think that the old shareholders of the West India and Panama Telegraph Company will look at this report which we present to-day with some satisfaction. It is, as a matter of fact, the best report in its results that we have ever had the honour of laying before you. There is an increase in the traffic revenue over that of the corresponding period of the previous year of £672, which is satisfactory. It does not bring the traffic of the past half-year up to the best we have had; but the last report that was better than the present in point of traffic was in 1885—a good long time ago. There is a slight increase in the working expenses, caused by the incidental fluctuations to which the working expenses are exposed in the increase of the length of service on the part of the staff, and there is a decrease of £3,459 in the expenses on repairs. That is a satisfactory item, which I hope now will be continued. Our average half-yearly cost of repairs for the half-year has been about £13,000, but this half-year it is about £11,000; so we are £2,000 under what we have been spending on the average. As to the detailed items in abstracts "A" and "B," I do not think there is anything that I need take up your time to remark upon; but if there is any question that any shareholder wishes to put, I shall be very glad to answer it. With regard to our present position and the immediate future of the Company, I feel that it is touching on rather ticklish ground. There is a great deal that comes before the Directors in the daily management of an affair like this that it would certainly not be expedient to talk about. Very often dangers we see in the distance may be made near by any allusions from the chair. At the same time, there has been so much correspondence coming through inflated views as to what our prospects are, that I think for the safety of the concern, especially in regard to its position as to the subsidies of the colonies, it is essential that I should caution the shareholders against too exaggerated views of what our possibilities and probabilities are. Our political horizon in the West Indies is never entirely free from clouds. You must know that a great part of our revenue depends upon subsidies, many of which are voted annually by assemblies popularly elected. At those meetings we cannot be present. We are not represented, and there is an old French saying that "the absent are always in the wrong." There are several parties about the world who are interested in coming in where other people have been established before, and therefore we sometimes find that very strange mis-statements and garbled accounts are given to those assemblies of what is the existing condition of the telegraphic service of the country. I may tell you that in one of our principal colonies not long ago it was stoutly maintained that there was only one cable landed on their shores, whereas there had been two cables for the past ten years; and this statement was believed in, and added to the obloquy which certain parties tried to cast upon the Company and its operations. We have, as I before told you, got a French company that is not inactive in those waters now. There are two French colonies — French colonies are extremely patriotic — and if they could see the tricolour flag flying where the Union Jack had been hitherto, they would very likely throw us over if that result were to be brought about. I mention these things, though there is nothing we anticipate adversely, rather to keep down any excitement that our comparative prosperity may bring about. I know that for the good working of the concern, for its happy position hereafter, for its favourable position in regard to the subsidies, it is very necessary that no inflated ideas should go forth as to the prosperity of the Company. What could be more injurious than that it should go forth to a Colony, perhaps not rich, that this Company was going to pay 4 or 5 per cent? "Why," they would say, "is not this a good opportunity to stop the £500 a year we give them?" I think the dangers are clear that any exaggerated views of our prosperity may bring about; and I hope the shareholders will keep themselves cool about the price and value of our shares. I have nothing more to say, but I should be glad to answer any questions. I now move:

"That the Directors' report and accounts to June 30, 1889, submitted to this meeting be and are hereby received and adopted, and that, as recommended by the Board, a payment of 12s. per share on the First Preference shares, being 6s. the balance of arrears and 6s. dividend to June 30th, and 10s. per share on account of arrears of dividend on the Second Preference shares, be and the same is hereby declared."

Mr. WILLIAM FORD: I rise to second the resolution of the honourable Chairman. During a period of 15 years—that is, from the time when this Board was called upon to assume the management of this unfortunate Company—it has devolved upon me (with few exceptions) to second at our half-yearly meetings the resolution for the adoption of the report and accounts. I have generally done so in the usual conventional formula, but there have been occasions when from circumstances at the time I have deemed it expedient to supplement the speech of my esteemed friend the Chairman by a few remarks, and with your concurrence I propose doing so on this occasion, because I think at this juncture we may justly and profitably do a little of what I will call stock-taking as to the present position and prospects of this Company. To put myself strictly in order, I beg to second the motion of my friend the Chairman. But in doing so I feel justified in interpolating the significant words with much satisfaction. It is very rarely indeed at our meetings that I could have used these words, and I think it due to those shareholders—to the shareholders I may say generally, but especially to those original shareholders who, during so many trying and disheartening years, have stood by this Board, trusting that their labours would eventually result in something like an approximation to a dividend upon the ordinary shares—I say I think it due to them that I should state specifically the grounds of my satisfaction. Gentlemen, my friend the Chairman has referred to one which is of considerable importance. It is referred to in the report, namely, that after the lapse of twenty years' submergence of our original cables in the treacherous coral and volcanic regions of the West Indies, the cables are in efficient working order. Further, my satisfaction is that we have, by the expenditure of no less than 1,600 miles of cable, costing a sum of £337,126 in repairs, and in deviations of some of the cables from dangerous into safer bottoms, so strengthened and vitalised the system that I think we may rely upon its doing good work for us for many years to come. Another satisfaction I feel is that the duplicate cables, which in length amount to, I think, 1,520 miles, and which were laid for the purpose of enabling us in the event of any breakages of parts of the original cables to preserve telegraphic communication and perform our contracts with the Colonies, are also in good working order. Another ground for satisfaction I have is this, that we have two well-found repairing ships in the West Indies, admirably captained and officered, prepared to do any repairs and work which the Board may call upon them to do. And while I am upon this subject, I really think it due to the present captains and staff of those ships to say—and I say it in the presence of such experts as Sir James Anderson, Mr. Andrews, Mr. Holmes, and Mr. Weaver—that the repairs have been effected in a most satisfactory and prompt manner [Sir James Anderson: Hear, hear.] I think it but just to the gentlemen who have commanded our ships, and in whose hands we are very much as to our repairs, to mention this. There is another ground of satisfaction which I have, and it is that we have in our ships and tanks cable of the value of £16,000, which I hope will be sufficient for some time to come. Well, now, gentlemen, I come to another point. We have succeeded after many laborious years in bringing together a substantial reserve fund, and what is more, we have succeeded in preserving it from the hands of the would-be spoliators. I say would-be spoliators because some gentlemen have come into this Company when the ordinary shares were under £1, not for the purpose of dividend, but for the purpose of giving a temporary value to the shares by endeavouring to obtain a portion of that reserve fund for division amongst the shareholders. We have withstood that, and shall continue to do so. I now come to what I may consider the last—I could mention others—and, in my opinion, the most important ground of satisfaction, and it is this: that we are now earning and receiving—and I lay stress on the word *earning*—the original subsidies, less the amount which St. Vincent and St. Thomas were obliged, by reason of the embarrassed condition of the finances of these islands, to withdraw, but plus the generous and much-needed additions by St. Lucia, Granada, Trinidad, Demerara, and the grant by Jamaica. Now, this is the first time in the history of this Company that these several circumstances to which I have adverted have been *co-existent*. True it is they have been growing from time to time, but this is the first time they have been co-existent, and it is therefore the first time that their cumulative force and effect upon the future of this Company and upon its present position could be taken into consideration. I said cumulative. We must make them for the future concurrent, because I do hold this, that if you withdraw from this fabric, which we have been for years building up, any of these favourable circumstances you endanger the stability of the whole edifice, of which I hold that the subsidies are the corner-stone. Gentlemen, I fear lest I should weary you, but since we came into office a new generation of shareholders, and, I may say, a new generation of colonists, have come into existence who know not Joseph; and they require to be reminded, and must be reminded, of the circumstances under which our original capital was subscribed—of the circumstances under which three-quarters of a million of further capital were subscribed to enable us to fulfil our obligations to the colonies in respect of which the subsidies were granted. It has been mentioned before, but I do not think it can be mentioned too often—it must always be kept before the shareholders, old as well as new, and before the colonists—what were the conditions, what were the terms, upon which this orignal capital was subscribed? They are contained in the pros-

Digitized by Google

pectus of the Company which I have before me. The prospectus estimated the traffic of the West Indies—that is their messages—at £156,000 per annum. Those estimates were sanctioned, or were countenanced, by gentlemen of the highest commercial standing in the West Indies. The Colonies, or, rather, those who represented the Colonies, were well acquainted with all these facts, and with the knowledge of such facts they granted the subsidies. Now what has been the result? Instead of a revenue of £156,000, at no period of the existence of this Company has it amounted to much more than one-third of that sum, and for some years considerably less, and for the whole period the average has been under one-third, whilst the working expenses have been, notwithstanding the most frugal management, more than double the prospectus estimate. I say, therefore, that it is our duty to insist, as far as it is possible for us to do so, that there should be reciprocity upon the part of the colonists in consideration of the great sacrifices which the shareholders of this Company have made. I do wish that those gentlemen who take upon themselves to enlighten the public by communications to financial newspapers, and who say that this Company is about to enter the dividend list—I do wish that they could give the public the whole truth, not partial truths. They are so exceedingly misleading. What are the real facts? I hold, after those representations upon which the original capital was subscribed—and upon which I omitted to mention it was estimated that the traffic, with the subsidies, would produce a dividend of upwards of 20 per cent. to the shareholders—that until the original shareholders of this Company have received something like an approximation to the amount of dividend they expected, plus a dividend for the current year, the West Indies have had the best of the bargain, and that we, by means, have had the worst of it. Certainly, we find ourselves after 20 years' establishment of this Company in an infinitely worse position by some millions than we were at the commencement. I assure you that this statement is not a *lapsus*—it is not a figure of speech. It is a word that can be demonstrated in figures, and in two or three words I will do so. The original capital was put at £650,000. The present capital of the Company is £1,200,000 odd. I have, therefore, got more than half a million. But now take what would have been the interest due on the ordinary shares of the Company if anything like an approximation to the prospectus had been given. This would have been the result: that we should have received in dividends, at 20 per cent., no less a sum upon the original capital than £2,256,000, or upon the increased capital £3,066,000; but let us come down from the altitude of 20 per cent. to the commonplace level of 5 per cent., and you will find that upon the original capital the result is £564,214, and upon the increased capital £766,500, in respect of which the ordinary share have received only three dividends of 1s. each. These are astounding figures, but they represent the sacrifices which the shareholders have made for the benefit of the West Indies, and to enable the Company fairly and properly to carry out their obligations upon which the subsidies were granted. It may be said—the Chairman adverted to it—that if a glowing account of the possible future of this Company should go abroad it may tend to a consideration in the West Indies whether we are able to stand alone without subsidies. Pray consider what I have said before, that the advantageous position, if such you may consider it, in which we stand at the present time is dependent upon the continuance of the favourable circumstances I have mentioned, because, as I have said before, if you withdraw one of them, the stability of the whole fabric is in danger. I could have said a great deal more, but I assure you that I could not conscientiously have said less, because I think something was due from me to those shareholders who, so many years ago, supported me in the struggle which led to the appointment of this Board.

Mr. FITZGERALD asked whether the Directors could see their way to the employment of one steamer instead of two. It was allowed at a former meeting by the Directors themselves and by the Chairman that if that state of things could be arrived at, there would be a very large saving indeed. He saw that during the last half-year one of the vessels was employed 82 days out of the six months, and the other vessel, the "Marlborough," was employed out of six months 36 days. He knew that the Chairman explained on the last occasion that there were dangers of losing the subsidy, but still if one vessel could be employed there would be a very large increase indeed in the amount available for distribution. And, moreover, a vessel, especially a steamer, deteriorated almost as much when it was not, as it did when it was employed. He also desired to ask the Chairman, whether in his opinion the time had not arrived when the present reserve, amounting roughly to £150,000, would be sufficient—with the interest it earned added to it every year—without drawing upon the earnings of the Company for further additions to the fund.

The CHAIRMAN: With respect to the question about the steamers, I can only repeat what I stated at the last meeting, that we should be very glad to get rid of one of the vessels. You will notice that one of them had to come to England for repairs.

Mr. FITZGERALD said that that made his argument rather stronger.

The CHAIRMAN: I do not know what we should have done if we had had to bring that vessel home without our having another one there. I do not think myself that at present we should be justified in doing away with one of our ships. It would be pulling out one of the stones of the fabric to which Mr. Ford referred. There might be a breakage of one of the cables, and there would be an agitation in the West Indies and a stoppage of subsidies, so that the saving would be very dearly paid for. What we shall be able to do in the future when we have the other two cables to Demerara and Barbadoes duplicated I cannot say. These cables are single, and we have to keep a ship about there to watch them. The other one is at St. Thomas, where it is more in accord with the main trunk line. If these two cables were duplicated it might be a question whether there should not be some modification. In reply to a question, he added: The length of one of the single cables is 300 miles, and of the other 100 miles, but the duplication would bring us no more traffic. With respect to the reserve fund, the whole of the amount is not reserve strictly speaking—it is reserve to meet depreciation, and every year a certain amount of deprociation occurs, which has to be met if we are to conduct our affairs on proper business principles. I should also say that a strong reserve was, independently of the question of depreciation, a most valuable thing for us in every way, in view of possible opposition, and to stop insane competition. It is insane to compete for traffic that cannot properly support one cable, and to lay another cable is insanity. I think, therefore, the existence of a good strong reserve which would enable you to fight is most likely to keep out anyone who has any sense upon the subject. He then put the motion in the usual way, and it was carried unanimously.

A vote of thanks was then passed to the Chairman and Directors, and in reply

The CHAIRMAN said that he would like to include in the compliment their excellent staff, both at home and abroad. He assured the shareholders that they had the services of a most able body of men.

The proceedings then terminated.

The Swan United Electric Light Company (Limited).

The seventh ordinary general meeting of the shareholders of this Company was held yesterday at the Cannon-street Hotel, Mr. J. S. Forbes presiding.

The SECRETARY (Major S. Flood Page) read the notice convening the meeting, and the Directors' report and statement of accounts were taken as read.

The CHAIRMAN then proceeded to give an analysis of the accounts, and said that the stock in hand on October 1st was £9,676; purchases, office expenses, Directors' fees, rent, salaries, and Mr. Swan's salary, amounted to £4,194. Wages and expenses at factories figured at £5,290, depreciation at £1,863, sales ledger reserve at £100, and the balance at £21,042. On the opposite side of the accounts they would find by sales, less commissions and allowances, £17,665; transfer fees and interest, £1,344; dividend to December 31, 1888, received from La Compagnie Générale des Lampes Incandescentes, £885; dividends to June 30, 1889, received from the Edison and Swan United Electric Light Company (Limited), less income-tax, £20,117; and stock, September 30, 1889, £3,770. In the last item it would be seen that there had been a considerable diminution from that of the corresponding heading on the debtor side brought forward on October 1st, amounting in round numbers to £5,000. The explanation of that item, as he had had from time to time occasion to mention, was that the Company could not carry on its business without having in hand ready for supply a great number of lamps of the various types which were required in the business. Those lamps, of course, must be manufactured and perfected and kept in store, and according to the volume of business would be the proportion of those lamps to those which had been manufactured and sold. Another reason why the figures diminished was that they had thought it prudent in the valuation of those lamps to bring them forward at 1s. instead of 1s. 3d. per lamp, for the reason that the cutting price in Germany was still going on, and it was deemed better to meet that possible depreciation of sale price by a corresponding reduction in the value of the lamps. They knew that the Company had parted with their patents, or rather with their separate existence as patentees, with respect to a considerable portion of their Continental business, to a company in Paris, of which they were members, La Compagnie Générale des Lampes Incandescentes, in which, in virtue of their amalgamation with the Edison Company, they received a certain consideration in the shape of shares for a portion of the value of their patents and business, and in which they subscribed a certain sum of money, £16,000, whereby they were the owners of 40 per cent. of that undertaking. Although that company had been in operation for a short time the result had been that a dividend had been declared to December 31, 1888, amounting to 6 per cent. They might congratulate themselves on the dividend to June, 1889, received from the Edison and Swan Electric Lighting Company (Limited). This was the first occasion on which the Directors of that Company felt justified in apportioning any portion of the profits of their undertaking to the purpose of dividend, but they had done it with perfect confidence in its legality and wisdom, and, as would be remembered, they declared a dividend of 7 per cent. on the capital invested, and 3 per cent. in addition, in the nature of a claim for contingent value in the Company, because the 7 per cent. was cumulative, and had to be satisfied out of the profits before the Deferred shares could receive anything. As they knew, for a number of years the Edison and Swan Company, like themselves, had to write down losses incurred in the initiation of the business in former years, and it was not until these losses were written out that they felt themselves free to determine to pay a dividend; but for the dividends payable by the Edison and Swan United and La Compagnie Générale des Lampes Incandescentes, they would have had nothing to divide. Their profit for the year came from the interest they had in those two undertakings. In other words, the Swan United existed principally as owners of shares in the Edison and Swan Company and in La Compagnie Générale des Lampes Incandescentes of France, which meant a combination on the Continent of Europe of the same character as that which had been so successful in England under the guise of the Edison and Swan United Electric Light Company. La Compagnie Générale had got all Europe, except Germany, before them. They had got an admirable factory, and there was every reasonable ground for believing that they would go on doing on the Continent, as had been done in England, a large business, resulting in considerable profits. So the Swan Company's separate manufacturing business was now limited to the Kalk factory, near Cologne, Germany, as he had explained when they were good enough to sanction the amalgamation being excluded from it for reasons which were then made clear. They had the Kalk factory on lease, which terminated next June. Between

Digitized by Google

now and then they would have to consider whether they would go on with the manufacturing of lamps there, or whether they should try and find—as they had been doing in fact—in Germany any combination to whom their interests might be handed over, or with whom they might become partners, on advantageous terms. Judged as it stood by the sales and the expenses, it was a very bad business, but those expenses could be materially reduced, because they had been able to re-arrange the German business since their fusion with the French company, by which they were already assured of a considerable reduction in the fixed charges during the current year. Depreciation, £1,863, was a larger item, but it was a precautionary measure. They thought it possible that circumstances might turn out to justify or require the abandonment altogether of the Kalk factory, which might entail some loss, and it was deemed advisable to write down the plant from time to time. The balance of £21,000 was profit on the year's transactions, which they could now recommend for division. They had had reasons, from time to time, for withholding the profits earned, because there were certain outstanding questions connected with the German business which made it desirable to reserve a substantial sum. They knew there was litigation going on for infringement of patents, and the process was exceedingly slow and unsatisfactory. It was possible in the course of time that they would be made out to be infringers and be liable to damages. No human being could say what those damages would be. By the German law they had had to deposit in the hands of the German Government about £5,000, but that sum might or might not be sufficient to meet the damages if there were any. Coming to the balance-sheet, he said he had no remark to make on capital, it being exactly as it was last year. On the opposite side, they would see by cost of patent rights, &c., represented by shares in Edison and Swan United Electric Light Company (Limited), with £208,478 paid; shares in La Compagnie Générale des Lampes Incandescentes, with £30,489. 8s. 3d. paid; patents held by the Company for Germany, India, &c., as per last balance-sheet, £329,911. 17s. 8d. That was what they invested in this Company, which in turn had invested in those two other allied companies. The additional expenditure thereon, £422, was spent partly on the patents themselves and partly on small legal expenses connected with them. They had reduced the outlay on factories, plant, &c., to £2,453. Sundry debtors, £3,324, were all good debts, and would more than set off the sundry creditors on the opposite side. Their investment in Prussian Consols cost £5,120, and their investment in New Two and Three-Quarter per Cent. Consolidated Stock cost £29,004, while they had cash on deposit and in hand £38,046. The report summed up the story he told them as follows:—"After paying all current charges, and making ample allowance for depreciation of plant, there is a credit balance of £21,042. 8s. 1d., to which must be added the credit balance of £10,052. 8s. 11d. brought forward from the last accounts, making a total of £31,094. 17s. The Directors will recommend the shareholders to declare a dividend of 6 per cent., which will absorb £22,208. 0s. 9d., to be distributed to the shareholders in accordance with Clause 77 of the Articles of Association." Having alluded to the possible collapse of the export trade from England, owing to cheap labour in Germany, and to the trade combinations, high rates of wages, and the uncertainties of manufacture in this country, he proceeded to say that that was a red-letter day in the history of the Edison and Swan Company so far as the Directors were concerned, because the shareholders could easily imagine what they felt when there was some dividend to pay in contrast with the dreary years they had passed through, with all their legal and scientific troubles to contend against, and no returns. He thought they were standing on safe ground. He trusted they would be satisfied with the state of things for the last year and with the outlook for the future. He believed the Edison and Swan report was sent to every proprietor. Well, they could see from that that they had very good prospects, a sound business, with patents—as far as they knew—invulnerable, with a lamp which increased from day to day in efficiency, and a large and growing output. The electric light, moreover, was now alive. There were companies now at work risking enormous sums of money upon every kind of device for giving London the benefit of the electric light. The shareholders of the Company would be the first to benefit from that, because those companies could not light without them. It seemed to him that the future was very hopeful, and probably in a few years the proprietors in both Companies would be amply repaid for the patience they had displayed and the positive loss they had incurred in being without dividend.

Mr. F. R. LEYLAND seconded the motion, explaining that the French Company were trying to do what had been done in the Edison and Swan Company—that was to say, they were litigating their Edison patent, with a view to establish it. That would be found, of course, troublesome, and to some extent risky, but if they succeeded in establishing their patent in France, as they established theirs in London, there was a career open to the French Company superior even to that of the Edison and Swan Company. That was where they would get their returns from.

Mr. A. SKAIFE asked whether there was not now on the market a great competitor in the shape of a lamp which had been taken up by Mr. Edison?

The CHAIRMAN said he was not aware of the existence of any such lamp, but if Mr. Edison did produce a new lamp he was bound to give them the benefit of the patent, being, as he was, enormously interested in this Company. He could not believe that Mr. Edison would go on improving the manufacture of the lamp and throw it open to all the world, to the detriment of his own property.

The resolution was carried unanimously.

On the motion of the CHAIRMAN, seconded by Mr. LEYLAND, the following resolution was also adopted unanimously:

"That the following dividends be declared for the year ended September 30, 1889, namely, a dividend of 6 per cent. per annum on the amount of £3. 10s. per share, being the amount which has been paid on the partly-paid shares, and of 5 per cent. on the fully-paid shares, and an additional dividend of 1 per cent. on the fully paid shares, reckoned for the purpose of this additional 1 per cent. as if £3. 10s. only had been paid on each of such fully-paid shares."

Mr. LEYLAND then proposed, and Mr. SWAN seconded in a few complimentary terms, the re-election of Mr. Forbes to his seat at the Board.

The motion was cordially agreed to, and

The CHAIRMAN, having briefly returned thanks for this renewed mark of confidence, proposed the re-election of Mr. E. W. Batt to his seat at the Board.

Mr. LEYLAND having seconded the motion, it was agreed to *nem. con.*

Subsequently the Auditors, Messrs. Welton, Jones, and Co., were re-appointed Auditors, and a vote of thanks having been passed to the Chairman and Directors, the proceedings terminated.

Woodhouse and Rawson United (Limited).

The first general meeting of the shareholders of this Company was held on Tuesday, at Winchester House, Old Broad-street, under the presidency of Sir Rawson W. Rawson, K.C.M.G., C.B.

The SECRETARY (Mr. Malcolm J. R. Dundas) having read the notice calling the meeting,

The CHAIRMAN said: Gentlemen, my first duty to-day is to convey to you the expression of the regret—extreme regret—of our esteemed Chairman, Lord Aberdare, which he forwarded to us in a note two days ago, that he was not able to attend this meeting. Some of you may be aware that he had a very serious illness just about the time of the formation of this Company, which confined him for a long time to his house in South Wales, and he is not able to come up to London for the

PATENT
SILICIUM BRONZE AND SILICIUM COPPER WIRE.
The best for overhead Telephone and Telegraph Lines,
AND ALL ELECTRICAL PURPOSES.
Hard Drawn High Conductivity Copper Wire.
ROLLED AND DRAWN
PHOSPHOR BRONZE.
PHOSPHOR BRONZE
BEARINGS, BUSHES,
AND OTHER PARTS OF
ELECTRICAL MACHINERY.
SOLE PROPRIETORS of the British, Indian and Colonial Patents,
THE PHOSPHOR BRONZE COMPANY (Limited),
87, Sumner Street, Southwark, London, S.E.
WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

Digitized by Google

express purpose of this meeting. My colleagues have done me the honour to ask me to fill his place—very inadequately, I fear—on this occasion. But the duty is so simple that perhaps I may not have a difficulty in acquitting myself of it. Our object in meeting to-day is to comply with the legal formalities of a statutory meeting within a limited time after the formation of the Company. We have not to ask your approval of any proposals to-day, but simply to report to you that all the essential formalities connected with the constitution of the Company and the amalgamation of the businesses of the several companies which are now united in this one have been completed. The attention of the Board has been necessarily directed mainly to that object, for there was a great deal of complication, as you can well imagine, in amalgamating, combining, and organising the business of so many companies, and such a variety of businesses—a manufacturing business, a supply business, a contract business, and foreign businesses. It has been a labour for the Directors which they have gladly undertaken, and which I hope they have successfully accomplished. We have also had the material difficulty of removing our old offices from the premises occupied by Woodhouse and Rawson (Limited) to those which we have now engaged, in a most convenient situation, and, notwithstanding that, we have the whole of the building to ourselves, I am happy to say, at a very slightly increased expense, close to the Mansion House Station, at 88, Queen Victoria-street. The premises look both into Cannon-street and Queen Victoria-street, and they are very capacious. They seem almost peculiarly adapted for a business of our nature, there being an extensive warehouse below and large rooms above the offices, where we can keep our stock, and, we hope, satisfy all our customers who come to us for electrical supplies. The Directors have made the shareholders acquainted with the circumstances of the Company from the beginning. In our circular of August 2nd we explained the circumstances that had delayed and hindered the original allotment of the shares. We have since informed our shareholders that a very important and very profitable contract, which was in negotiation at the time of the formation of the Company, has been completed, and promises as profitable a result as that which distinguished the last year of the existence of Woodhouse and Rawson (Limited). The business was one of the matters taken over by us incomplete; it has since been completed, and it justifies us in assuring you that the prospects held out in the original prospectus may, or rather will, be realised. You know that you have the security of the original Company for a guaranteed dividend for the first three years, by having placed in our hands a large deposit to be used as working capital beyond that realised from our own shares, so that by the end of three years we shall have got into a very large and profitable business. There has been perfect evidence of the wisdom of the original Company extending itself in this direction. We have by organisation economised very largely the costs of administration. By the possession of increased capital we have received large offers—important offers—of business which were not likely to be offered to the other Companies because they would not have had the capital to carry them out, and if they had been offered, they were not in a position to accept them. We may do so now, and with our existing capital I can safely say, on the part of myself and co-Directors, that the business now in hand offers a realisation of what the promoters of this Company held out. I was not one of the promoters, for I had no connection with it in its original form except from the fact that my son was interested in it. I was interested in his success, of course, but I was in no way concerned in his commercial undertakings. I am now interested in it, and I feel my co-Directors have also manifested a very sincere and earnest interest in the success of the Company, and I think I may honestly say to you that the prospects before the Company are quite as good as they were held out in the original prospectus, and in the more recent one that was published on the occasion of our issuing a fresh number of shares at a premium. I do not think I have anything more to say to you. What we had to say has been said in our several addresses to our constituents; an important point I may here say, is that what we have there said has been confirmed by our examination and by our work during the last four months. In conclusion, for I need not detain you further, I would draw a happy omen from the title of our Company. We are now not merely a limited company, but a united company. I may say for my colleagues on the Direction that we are thoroughly united, and I hope they will confirm, if necessary, what I have stated to you to-day, and I sincerely hope that when we meet, as I trust we may before long, to address you more particularly with regard to the details and earnings of the Company, we shall be able to make such a statement as will insure not only a united body of Directors, but a united body of shareholders also, and that we may receive their support, and derive all the advantages we hope to obtain from it. I shall be happy, to the best of my ability, to give information, if any one requires it, but otherwise the business of the present meeting is concluded.

Sir J. STOKES, K.C.B., fully confirmed all that Sir Rawson Rawson said as to the position and prospects of the business. Having been engaged in the business of the old Company for the last few years, he was, perhaps, in a good position to say that he thought things now looked even better than they had ever done before.

The CHAIRMAN said that if the shareholders desired to ask no information, that was the end of the meeting that day. They would meet again at an early period, perhaps at the beginning of the year.

NEW COMPANIES REGISTERED.

LANGE AND CO. (LIMITED).—This Company has been registered to acquire the business of Lange and Co. at Boulogne-sur-Mer, and to carry on the business of electrical engineers. Capital £10,000, in £50 shares. Amongst the subscribers of one share each is Mr. George H. Verity, 31, King-street, Covent Garden, who is also one of the first Directors.

THE PRIESTMAN OIL ENGINE AMERICAN SYNDICATE (LIMITED).—Objects: To purchase the Priestman and Hume's patents relating to hydro-carbon engines for the United States of America, and there to carry on the business of mechanical engineers, iron founders, and engine builders, and makers and dealers in electric power and lighting. Capital £25,000, divided into 1,250 preference shares of £10 each, and 1,250 ordinary or deferred shares of £10 each. Preference shares confer a right to dividend of 10 per cent. Directors, not less than five nor more than seven. First directors: E. P. Maxted, John Sherburn, Harrison Holt, James Reckitt, Samuel Priestman, and Joshua Priestman.

THE TRANSVAAL OIL ENGINE COMPANY (LIMITED).—Objects: To acquire patents rights for inventions in petroleum engines; to ratify an agreement between the Hamilton Syndicate (Limited) and Alfred John Cooley; and to carry on in the Transvaal or elsewhere the business of mechanical engineers, manufacturers of engines, and workers and dealers in electricity, motive power, and light, and so on. Capital £25,000, in £5 shares. Directors, not less than two nor more than five, to be appointed by subscribers.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The receipts of this Company for the week ended November 8th amounted to £4,636.

CROMPTON AND CO. (LIMITED).—An interim dividend, at the rate of 7 per cent. per annum, has been declared by the Directors of this Company for the past half-year, payable on December 14th next, carrying forward a balance of net profits for the half-year sufficient to pay the preferential dividend at the same rate for the next half-year.

GREENWOOD AND BATLEY.—The Directors have declared the following interim dividends for the half-year ended September 30th, payable on the 14th inst.:—At the rate of 7 per cent. on the Cumulative Preference, and of 10 per cent. on the ordinary shares.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended November 8th, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,172.

WOODHOUSE AND RAWSON UNITED (LIMITED).—Letters of allotment and regret have been posted.—This week the Company have gone into their new premises at 88, Queen Victoria-street, London, E.C., to which address all communications are in future to be sent. We are also desired to announce that the firm's telephone number is now 1978.

THE NON-CONDUCTOR OF ELECTRICITY.

VULCANISED FIBRE,

PATENTED.

This new material is supplied in two qualities, Flexible and Hard.

The FLEXIBLE is a substitute for Leather, Rubber, Gutta Percha, &c., and is extensively used by Brass Founders, Axle Makers, Hydraulic, Sanitary, and other Engineers, Pump Makers, Carriage Builders, &c.

It makes the best Hot and Cold Water Packings, and for Axle Washers of all kinds it is unequalled.

The HARD is a substitute for Metals, Hard Wood, Ivory, Vulcanite, Ebonite, &c., and is a good Insulator.

Sold in sheets, 5ft. 6in. by 3ft. 6in., varying in thickness from 1-50in. to 1in.

FLEXIBLE, 2/- per lb.; HARD, 2/3 per lb.

FACTORY.

MOSSES & MITCHELL, 70 Chiswell-st., London, E.C.

Digitized by Google

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Wednesday, Nov. 13, 1889.	Rate per cent. Yielded.	Dividend Due.	Business done during Week Ending Nov. 13, 1889.	
£			**TELEGRAPHS.**		£ s. d.		Highest.	Lowest.
1,770,360	Stock	12/6	Anglo-American	50½ 51½	4 17 1	Jan., Apr., July, Oct.	51	50½
2,614,820	Stock	25/0	Do. Preferred	86 87	6 6 5	,, ,,	87½	85½
2,614,820	Stock	...	Do. Deferred	16½ 17	...	February	16¾	16¼
130,000	£10	5/0	Brazilian Submarine	13 13½	5 18 6	Mar., June, Oct., Dec.	13¼	...
112,900	£100	5%	Do. 5 per Cent. Bonds	101 103	4 16 9	January and July	...	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	106 109	4 11 9	June and December.	...	...
16,000	10	9/0	Cuba Submarine	14½ 15	6 0 0	February and August	14½	...
6,000	10	10/0	Do. Preference 10%	20 21	4 17 9	,, ,,	...	...
12,931	5	2/0	Direct Spanish (£4 paid)	3¾ 4¼	3 15 4	March & September	...	...
6,000	5	5/0	Do. Preference 10%	9 10	5 0 0	April and October	...	...
60,710	20	3/6	Direct United States	10½ 10¾	6 15 11	Jan., Apr., July, Oct.	10½	10 3/16
380,000	10	2/6	Eastern	13⅞ 14⅛	4 12 0	,, ,,	14 1/16	13⅝
70,000	10	3/0	Do. 6 per Cent. Preference	15¼ 15¾	3 16 2	,, ,,	15¼	...
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock xd	106 108	3 14 1	May and November.	108	107
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	107 110	4 10 11	February & August	107	...
250,000	10	2/6	Eastern Extension	13⅛ 13⅜	4 14 6	Jan., Apr., July, Oct.	13⅜	13⅛
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	102 104	3 16 1	February & August	103⅛	102½
475,000	100	5%	Do. 5 per Ct. (Austrln. Gov. Sub.) Debs. 1900	104 107	4 13 6	January and July	...	...
179,177	10	2/0	Globe Telegraph and Trust	8⅜ 9	5 11 1	Jan., Apr., July, Oct.	8 1/16	8⅜
178,992	10	3/0	Do. 6 per Cent. Preference	14⅜ 14⅞	4 0 8	,, ,,	14⅞	14⅜
150,000	10	5/0	Great Northern	15½ 16	4 13 9	Jan., July, and April	...	...
17,000	25	12/6	Indo-European xd	41 43	5 16 3	April and October	42½	...
9,000	8	4/0	Reuter's	7 7½	5 6 5	April and October	7 1/16	7
15,609	10	5/0	West African Telegraph	9½ 10½	...	...	...	...
300,000	100	5%	Do. 5 per Cent. Debentures	99 102	4 18 0	March & September	...	...
30,000	10	5/0	West Coast of America	10½ 11	5 0 0	January and July	10⅝	10⅜
150,000	100	8%	Do. Debentures 8%	122 127	6 6 0	June and December	...	...
88,321	10	nil.	West India and Panama	3 3¼	...	...	3⅛	2⅞
84,563	10	12/0	Do. 1st Preference 6%	12½ 13	...	April and October	12 1/16	12⅛
4,669	10	†	Do. 6 per Cent. 2nd Preference	15 16	...	...	15⅝	...
45,181	15	9/0	Western Brazilian	9½ 10	7 10 5	May & November	10 1/16	9⅝
$1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage xd	111 114	6 2 10	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	100 102	5 17 8	March & September	...	...
			TELEPHONES.					
224,850	14/0	5%	Consolidated Telephone and Maintenance xd	1 1/16 1⅛	4 14 9	Yearly	...	...
220,000	£1	3%	Oriental (11s. paid)	1/16 1/16	3 15 11	...	...	...
*	*	nil.	National	5⅞ 6⅛	...	...	6⅛	5 11/16
55,000	5	3/0	United River Plate	5 5⅛	...	January and July	5⅛	...
			ELECTRIC LIGHT.					
23,692	5	2/0	Anglo-American (fully paid)	5 5⅛	...	February & August	...	...
79,934	5	6%	Swan United (£3. 10s. paid)	4⅝ 5⅛	4 0 0	...	5⅛	4⅝
500,000	10	...	Metropolitan Electric Supply (£3 paid)	5¼ 5⅜	...	...	5 1/16	...
			MISCELLANEOUS.					
37,350	12	12/0	Telegraph Construction and Maintenance	44 45	5 6 8	March and July	45	44½
41,600	10	10/0	India Rubber, Gutta Percha & Telegraph Works	18½ 19½	5 2 7	February & August	19	18½

† No dividend since May, 1880.

JABLOCHKOFF'S
DISTRIBUTION PATENT

(Being a Patent for "Producing and Dividing Electric Light," No. 1996 of 1877.)

THE UNITED ELECTRICAL ENGINEERING COMPANY (LIMITED)

Are Proprietors of the above Patent, and Warn the Public against Infringement.

The following are Licensees:—

Anglo-American Brush Electric Light Corporation, Limited.
Crompton & Co., Limited.
S. Z. de Ferranti.—London Electric Supply Corporation, Limited.
W. T. Goolden & Co.
Hammond & Co.
Wilson Hartnell.
Johnson & Phillips.
Laurence, Paris & Scott, Limited.
Nalder Brothers & Co.
Paterson & Cooper.
Ernest Scott & Co.
Siemens Brothers & Co., Limited.
J. G. Statter & Co., Limited.

3, Prince's Mansions, Victoria Street, Westminster.

MANVILLE & MADGEN, *Managing Directors.*

Digitized by Google

THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 601.—Vol. XXIV. FRIDAY, NOVEMBER 22, 1889. Price Fourpence.

NOTES.

We are pleased to notice that our correspondent "Telegraphy" is this week a little less irreconcilable than appeared from his first letter. The grievance to which he has given such vigorous expression will now probably be removed, and a fuller representation secured for the varied interests concerned with electrical science.

After a lengthy debate the Edinburgh Town Council has by 25 votes to 8, approved of the minute passed at the last meeting, embodying a resolution the practical effect of which was to leave it open to the Corporation either to apply for an electric lighting Provisional Order on its own account, or to enter into an arrangement with one of the six companies who are competing for the honour and profit of supplying Edinburgh with the electric light. The debate was only noteworthy in so far as it brought out in a very clear manner that many of the members of the Edinburgh Town Council are haunted with the fixed idea that the granting of a Provisional Order to a private company means a 42 years' monopoly, and the tearing up of the streets in all directions without let or hindrance on the part of the local authority. Many of the local authorities have thus been induced either to take up an unreasoning attitude of opposition to the introduction of the electric light, or to lodge applications for Provisional Orders without any intention of using their powers when obtained. A cursory study of the Electric Lighting Acts, and of the model Provisional Order, would, we are confident, convince members of local bodies that the progress of the electric light in this country is far more likely to be hampered by undue restrictions than that the districts under their jurisdiction will become the prey of unfettered monopolists.

If the alternate-current motor difficulty is not shortly overcome, it certainly will not be for lack of endeavours to solve the problem. We publish this week two attempts in this direction, one due to Mr. Van Depoele, of street-railway fame, and another due to Dr. Sumpner. Prof. Ferraris, it will be remembered, proposed to employ a transformer wound with two secondaries to excite his field-magnets. In one secondary there was as much inductance and as little resistance as possible, while in the other there was high resistance and small inductance. In this manner the phase of the two currents was displaced to nearly 90deg., and the copper ring he employed was rotated. Mr. Nikola Tesla obtained the same result by winding opposite quadrants of his field-magnets with two independent circuits traversed by currents relatively displaced by $\frac{1}{4}$ phase. Mr. Van Depoele winds what may be termed his primary coil on to one set of magnets arranged outside the armature, and his secondary on to another set arranged inside the armature, with poles midway between those of the external magnets. Dr. Sumpner proposes to do away with the disadvantage under which the Tesla motor labours of requiring a special third wire, by an ingenious adoption of Prof. Ferraris' device, alternate quadrants of the Tesla motor field-magnets being wound with several turns of fine and a few turns of thick wire.

Mr. Thomas D. Lockwood, of telephonic fame in the United States, has been giving to the members of the American Institute of Electrical Engineers his impressions of British telegraphy, telephony, and electric lighting, formed during a recent visit to this country. On the whole they are shrewd, appreciative, and just; while in some respects they are suggestive and instructive even to English readers. With regard to one or two points, however, his remarks will strike them as particularly odd—for example, the reflections on our Government control of the telegraphs. He is pleased to approve of it for this or any other country where the Government is monarchical, "whether limited or absolute"; but not for a republican Government, subject, like that of the United States, to "radical and sweeping changes." Mr. Lockwood could, no doubt, give us a better reason than this if he tried. The Government of the North American Continent has proved more permanent than the monarchical ones of the Southern Continent; and we never hear of the telegraphs being swept away, however sweeping the political changes may be. His real reason probably is that where politics is a trade, and spoils are to the victors, the administration of a huge Government business might be made the instrument of jobbery and corruption. That, we believe, is the view commonly expressed in America; and we are inclined to agree with it in preferring private monopolies to public plundering by political adventurers.

Both Lord Rosebery and Mr. Henniker Heaton are so much in the habit of mixing in strange society that it does not surprise us to see them joining hands on the platform of

Digitized by Google

Imperial Federation. The Conservative member for Canterbury seems to have convinced both the noble Home Ruler and the Unionist *Times* that the shortest way to secure the aims of the Federation League would be to cheapen the postal and telegraphic rates to our Colonies. This may or may not be the case, but if the whole scheme of federation is to be carried out on the same principle as the cheapening of mail and cable service—that is to say, at the expense of the mother country, we fancy that the project will not make much headway. As regards cable rates, they could be cheapened to-morrow if the Colonies would only take their fair share of the cost and the risk of doing it.

A SHORT time ago the newspapers reported a banquet of Pears' soap celebrities; last week one, if not more, of the daily papers admitted a letter from the Medical Battery man, complaining of the dirty condition of the footpaths in Oxford-street and Holborn. Intending patients could not make their way to the famous electrical hospital in consequence of the mud, and business was falling off. There probably is no doctor or physician in London who could get space in the papers for a similar complaint. But doctors and physicians, as a rule, do not advertise, and that may account for a good deal.

THE latest suggestion in the way of electrical conduits which comes to hand from Boston, does not commend itself to us as being either cheap or effective. It is proposed to employ indurated fibre pipes filled up with flake mica, and run cotton-braided wires through the ducts. We do not think the insulation thus obtained would be particularly high, and the cost of such large quantities of pure mica would probably prove prohibitive.

THE old adage that "Necessity is the mother of invention" has once more been exemplified by the Julien Company of New York. Since the rendering of the decision in the United States Circuit Court preventing them from applying active material to their accumulator plates in the form of paste or paint, this Company has discovered that dry powder, compacted upon the grid by hydraulic pressure, gives results far superior to any hitherto obtained. This is not the first time that the necessity of "getting round" a patent has given rise to valuable discoveries of that character.

WE hear that Mr. CROMPTON has turned his attention to the improvement of the Fritsche "wheel" dynamo, which was described in these columns in April last. There are some who think that in these coreless armature machines, such as the Fritsche and Desroziers (*The Electrician*, October, 19, 1888), we see the dynamos of the future—at any rate for heavy central station work; and if Mr. CROMPTON transforms this latest foreign importation as completely as he did the old Bürgin machine, its performance will excite considerable interest.

AN association is, we are glad to hear, in the course of being formed, under the title of the "Gilbert Club," for the purpose of bringing out an English edition of Dr. GILBERT'S much-talked-of but too-little-read "De Magnete." It is proposed to reproduce as nearly as possible the fine folio edition of 1600. Another object of the "Gilbert Club" will be to organise a fitting celebration next year of the tercentenary of this old English worthy. Only a limited number of invitations to join the Club have been issued, and among those who have already consented to become members are Sir WILLIAM THOMSON, Lord RAYLEIGH, Prof. TYNDALL, Prof. REINOLD, Prof. RÜCKER, Prof. FORBES, Sir DAVID SALOMONS, Mr. W. H. PREECE, and Mr. LATIMER CLARK. Prof. SILVANUS THOMPSON'S enthusiastic advocacy of the claims of the "Colchester philosopher" to immortality is well known, and he gives his support to the scheme by occupying the onerous position of honorary secretary. The first meeting of the Club will be held next Thursday, at the Society of Arts.

Barnsley.—The Corporation intend to apply for an electric lighting Provisional Order.

Wednesbury.—The Town Council has unanimously resolved to make application for an electric lighting Provisional Order.

Tiverton.—At a meeting of the Town Council on Monday it was unanimously decided to apply for an electric lighting Provisional Order.

Levenshulme.—Consent has been given by the local Board to the application of the Manchester House-to-House Electricity Company for a Provisional Order.

Madrid.—Trials will shortly be made on the different tramway lines in Madrid of the Sprague and Thomson-Houston systems, and also of an accumulator car.

Ohm Memorial Fund.—The Committee of the Ohm Memorial Fund announce that, the subscriptions having reached the sum of £125, they propose to close the collection.

Portsmouth.—It has been decided to issue at once the necessary notices of the intention of the Corporation to apply for a Provisional Order to supply the electric light.

Ballymena.—A committee has been formed to take steps to form a local electric light company. Considerable support was given to the scheme at a recent meeting in the town.

Edinburgh International Exhibition.—It will be seen from our advertising columns that the Executive Council are prepared to consider tenders for the lighting of the Exhibition buildings and grounds.

Electric Lighting Provisional Orders.—The applications for Provisional Orders lodged with the Board of Trade up to date amount to 430, and power to apply for further Orders remains open until the 30th inst.

Hamilton.—At the last meeting of the Town Council the Provost reported that, carrying out the resolution of the Council in July last to apply for a Provisional Order, the statutory notice had been prepared.

The Eastern and South African Telegraph Company.—This Company announces the drawing of 283 £100 Debentures for payment at par on January 1st next. Full particulars are given in our advertisement columns.

Ayr.—The Town Council, on Saturday, unanimously resolved to apply for a Provisional Order in order to light the town with electricity. It has been estimated that an electric installation for Ayr would cost from £18,000 to £20,000.

Swindon.—The Swindon New Town Local Board will receive tenders up to the 25th inst. for lighting, "by gas or other illuminant," the district under their authority. Further particulars can be obtained of Mr. H. Kinneir, clerk, New Swindon.

Dundee.—A joint meeting of the Town Council, Police Commission, and Gas Commission was held, on Monday last, to

Digitized by Google

consider the question of electric lighting. After considerable interchange of views, it was agreed, by 15 votes to 3, to jointly apply for a Provisional Order.

Sale by Auction.—Messrs. Wheatley Kirk, Price, and Goulty announce the sale, early in December, of the entire contents of the Victoria Engine Works, Chester; and they further notify that the lease of the works is also for sale. Particulars will be found in our advertising columns.

A New Soldering Flux.—We have received from Mr. Watkins, of Eccles, a sample of his liquid resinous flux. The solder flows very easily with this flux, and as it is said to contain no acid or alkali, it ought to prove useful for soldering connections in electrical instruments, cables, &c.

Appointment Vacant.—The Directors of the Great Eastern Railway Company will receive applications up to the 26th inst., for the appointment of telegraph superintendent and engineer, rendered vacant by the death of Mr. H. Sach, at a salary of £500 per annum. Further particulars will be found in our advertisement pages.

Cambridge.—At the last meeting of the Town Council it was decided to publish the necessary advertisements in connection with the proposed electric lighting Provisional Order and to call a special meeting of the Council for December 12th. In the meantime the whole question is to be referred to a committee, with power to consult an expert, for inquiry and report.

Electricity in Mining Operations.—About 70 gentlemen from various parts of the country accepted an invitation to visit St. John's Colliery, Normanton, on Wednesday, to inspect the electric pumping and hauling plant which Messrs. M. Immisch and Co., of Kentish Town, have there put down for Messrs. Locke and Co. Great satisfaction was expressed with all that was seen.

Newcastle.—The Chairman of the Newcastle and District Electric Lighting Company has written to the Mayor proposing that as a way out of the present legal deadlock the Company should deposit a sum of money with the Corporation, and that the Company should enter into an agreement allowing this sum from time to time to be applied towards the payment of any penalties that may be incurred by the Company.

The Preparation of Ozone.—Owing to its extraordinary oxidizing properties, ozone, if it could be produced on a commercial scale, would find many industrial uses. A M. de Vars employs, but with what success is not stated, two concentric tin-coated cylinders enclosed in a bell jar. The two cylinders are connected to a powerful source of electricity, and a current of air is passed between their adjacent surfaces, the ozone being then drawn off.

Hull.—The Corporation have refused their consent to the applications of the electric lighting companies for Provisional Orders, and the Town Clerk has been instructed to take the necessary steps for obtaining a Provisional Order authorising the Council to supply electricity for public and private purposes within the borough. A Special Committee has also been appointed for the purpose of dealing with the question of electric lighting within the borough.

Electric Traction at Plymouth.—The Plymouth Tramway Company is about to complete and equip the line for which renewed parliamentary powers have recently been obtained, and is prepared to receive proposals for traction by cable or electricity. Applications should be made before December 5th, by letter only in the first place, to the Secretary, Plymouth Tramway Company, care of Messrs. Walter Webb and Co., 28, Queen Victoria-street, London, E.C.

Proposed Electric Railway in the City.—At the last fortnightly meeting of the City Commission of Sewers a letter was read from the solicitors to the company which proposes to seek Parliamentary powers next session to construct an electric railway from Holborn, through Newgate-street, Cheapside, and ending in King William-street, asking for instructions as to posting street notices regarding the same. After some discussion, the whole business was referred to the Streets Committee for consideration and report.

C. and C. Electric Ventilating Motors.—All the motors exhibited by Messrs. Shippey Brothers (Limited) at the Birmingham Exhibition were sold. One has been fixed at a brewery in Burton-on-Trent, one for ventilating a bank in Yorkshire, two for ventilating the smoke rooms at a hotel in Manchester, and four for various circuits in Bradford, Leeds, Liverpool, and Birmingham. Ten of the C. and C. fan sets have also been fitted in the new steamship "Teutonic" for ventilating the saloons, kitchens, smoke rooms, &c., for the White Star Line.

Electric Traction at Birmingham.—Sir John Fowler, K.C.M.G., and Mr. W. H. Preece, F.R.S., having been deputed by the Government of New South Wales to investigate the question of electric traction in England, inspected on Saturday last the electric car constructed by the Electrical Construction Corporation for the Birmingham Central Tramways Company. The trial was completely successful. The Electric Construction Corporation, we may add, have received an order for twelve accumulator tramcars from the Birmingham Central Tramways Company.

Electric Traction in Brisbane.—In their last half-yearly report the Directors of the Metropolitan Tramway and Investment Company expressed the opinion that so long as horse traction was employed so long would the Company be subject to abnormal fluctuations in expenditure, and the Directors announce that requests for permission to substitute an electric overhead wire system for horse traction have been forwarded to the various local authorities around Brisbane. In addition to this a second tramway company has been formed, which proposes to work its lines by electricity.

Electric Lighting at Alnwick Castle.—The installation at Alnwick Castle will, when completed, comprise some 700 lights. The motive power is obtained from the Abbey Mill, where a 30 horse-power turbine, and a 19-unit Elwell-Parker dynamo are installed. From the dynamo the current is taken to a battery of fifty-six 314 E.P.S. cells, situated in the Falconer's Tower. From the regulating switch-board the cables are taken in cast-iron pipes to the distributing board. The whole of the casings have been cyanised. The carrying out of this large installation has been entrusted to Messrs. Drake and Gorham.

Hastings.—An application will be made by the Corporation for a Provisional Order empowering the Council to supply electricity within the borough for public lighting. The Corporation have also given consent to the Provisional Order of the Hastings Electric Light Company for public and private lighting. The report of the Lighting Committee of the Corporation stated that the estimated cost of machinery for providing 50 arc lamps would be about £5,828, and the annual cost of working the same would be £1,000, as compared with the £1,181 cost of maintaining the gas lamps and electric light lamps at present in use.

Gravesend.—The question of lighting the borough of Gravesend with electricity, and in connection with which it was resolved at a previous meeting of the Town Council to give consent to all the companies applying for Provisional Orders, has been re-opened, it having been ascertained that the giving of consent to the whole would deter any of the companies from moving. Under these circumstances, it was resolved, after considerable discussion, and in direct opposition to the previous decision of the Town Council, that no consent should be given to any of the companies; this decision being attained by eight votes to seven.

The Insulation Resistance of Porcelain Insulators.—In a recent number of the *Centralblatt für Electrotechnik* Herr Schomburg gives the results of some tests made in Berlin of the insulation resistance, in various states of the weather and temperature, of a double bell insulator, measured with an electromotive force of about 100 volts at a height of 7ft. from the roof. The highest resistance obtained was 58,432 megohms; this figure being reached at noon on a warm, sunshiny day in March. About six weeks later the same insulator only showed 180 megohms resistance, the test being taken at 5.30 a.m., when there was a heavy dew. The next day, in the pouring rain, the resistance was 1,051 megohms. On the same day that the

Digitized by Google

resistance of the insulator at noon was 58,432 megohms, at sunrise it was only 630 megohms.

The "Agir" Motor.—The prize of 100 guineas offered some two years ago by our contemporary *Industries* for the electric motor which best fulfilled the conditions then laid down as regards weight, speed, efficiency, &c., has been awarded to Messrs. F. V. Anderson and J. O. Girdlestone, the designers of the "Agir" motor. To decide the prize two 10 horse-power motors were actually built after what were considered the two best designs, and officially tested at the Silvertown Works. The following data are furnished by our contemporary:—

E.H.P. Supplied	Speed of Motor Spindle.	Mechanical horse-power given off motor spindle.
11·81	248	7·31
14·85	285	10·6
12·70	252	9·48

The motor is a two-pole series-wound machine, weighing 985lb., and is designed to work with a current of 150 volts pressure.

Royal Meteorological Society.—At the first meeting of this Society for the present Session, the "Second Report of the Thunderstorm Committee" was read. It was a discussion by Mr. Marriott on the distribution of days of thunderstorms over England and Wales during the 17 years 1871—87. Notices of sheet lightning are included in the term "thunderstorms." The years of greatest frequency were 1880, 1882, 1884, and 1872; and the years of least frequency 1887, 1874, 1879, and 1871. Years of greater or less frequency alternate regularly throughout nearly the whole of the period. The average yearly number of thunderstorms is about 39. The districts with the greatest yearly frequency are the south of England and extreme northern counties: and those with the least yearly frequency are Cheshire, Lancashire, and Yorkshire. The greatest number of thunderstorms occur in July, and the least in February and December.

The Influence of Dielectric Media on Electric Forces.—M. A. Stepanoff has devised the following apparatus to exhibit the modifying influence of a dielectric medium upon the intensity of electric forces. A very light horizontal Zöllner pendulum is arranged in its position of equilibrium with a disc of paper, 4 cm. in diameter, attached to its extremity. On either side of the paper are two metallic discs of the same diameter. The whole system being statically charged, a disc of some dielectric substance is introduced on one side of the paper, which is immediately displaced, showing that the forces of repulsion no longer balance. The same experiment succeeds, though in a lesser degree, when the metallic plates are oppositely charged. The effect is very well seen when ebonite, mica, or varnished-glass discs about 15 cm. thick are employed, but it is necessary that they should be completely discharged by being passed through a flame.

Co-operative Telephones.—At a meeting of a number of users of the telephone, recently held in Manchester, it was decided to send circulars to the commercial community of the city to ascertain the extent of support that would be given to an association on co-operative principles. The circular which has been issued states that estimates have been prepared by a competent engineer, which show that the establishment of an exchange of 1,500 users will require a capital of about £12,000, and will cost yearly for maintenance about £6,000, or, say for each user, about £4 per annum. The cost of private telephones in offices and warehouses would not exceed £1 per annum each, which would give users the great convenience of instruments in every department for a trifling charge. The present exchange charge in Manchester is £20 per annum, and there are about 1,300 renters within a radius of one mile; but at a rental not exceeding £5 per annum, it is believed an exchange of 2,000 to 3,000 renters can be formed.

Canadian Telegraphs.—Mr. Gisborne, Government Superintendent of the Telegraph and Signal Service of Canada, during the past summer completed the land lines upon the North Shore of the Gulf of St. Lawrence, to Point aux Esquimaux, about 660 miles below Quebec. This line is constructed with cedar poles, No. 6 galvanised iron wire, and No. 9 tie wire, purchased from the Whitecross Company, of Warrington, England, Gisborne's porcelain insulators being used. The Director of the Quebec Observatory, who has been determining the correct longitudes and latitudes of various points in the Gulf, speaks very highly of the efficiency of the new line. From Point aux Esquimaux the Canadian Government are about to lay three loop cables next summer to the Straits of Belle Isle, viz., one of 75 knots, to Natashquan, thence by land line, 25 miles, to Kegashka; thence, 114 knots, to Meccatina; and thence, 84 knots, to Greenly Island. This will form one of the connections with the proposed Canada Atlantic Cable Company, a second and third connection being made direct from Greenly Island with the Government systems upon Anticosti, and with the province of Quebec.

Keighley.—At the last meeting of the Town Council the Gas Committee recommended that the Town Clerk be instructed to apply for a Provisional Order. Alderman Brigg, in moving the adoption of the report said that notices had been received from two electric lighting companies. The Committee considered these applications, and they were of opinion that it was very undesirable that an outsider should have powers. With that view the Council declined to accede to the requests of these two companies, and as a result of that refusal the Town Clerk had received a letter from one of them withdrawing their application. The other company had not as yet withdrawn its application, and therefore it was necessary that the Council should put itself into a position of being able if necessary to proceed with the electric lighting for itself. He believed that in the event of the other company withdrawing their application, the Gas Committee would not prosecute their application this session. The Committee had no wish to adopt a policy of doing nothing themselves and refusing to allow anyone else to do anything, but they were rather wishful of obtaining as much information as could be had before starting on such an undertaking as this. The report was adopted.

Electric Light Installation on the "Admiral Nakimoff."—The "Admiral Nakimoff" is the first Russian battle-ship lighted throughout by electricity. The installation was set up by the Jablochkoff Company, and consists of four compound-wound 320-light 65-volt Gramme dynamos, driven by four separate engines. The engines working each pair of dynamos are connected by separate steam pipes to both the main and auxiliary boilers. Each dynamo can be switched on to any circuit at will, and each pair of dynamos can be connected in parallel arc. The mains form three closed double circuits, all connected to the main switch-board. Two of these double circuits supply the gun and main-decks, one pair extending along the port side of the gun deck, descending at the bows to the main-deck thence led aftalong the whole length of the port side of the main-deck, and ascending at the stern to the gun-deck, where the respective conductors join, and thus form each a complete circuit. The second pair of conductors travel along a parallel path, but on the starboard side of the vessel. The third pair of conductors supply the engine-rooms, stoke-holes, and magazines. The corresponding mains of the port and starboard circuit on the gun and main-decks can be connected together at the fore and after part of the ship by means of switchboards, to which they are connected by supplementary conductors. The lights on the fore and after orlop-decks are regulated by auxiliary switchboards, so that they can be fed direct from the dynamos, or, in cases of need, from 150 accumulators on each deck. The advantages claimed for this system of lighting on war-ships are, that the laying of the conductors on the gun and main-decks in an annular path prevents the extinction of any lamp, in the case of a single injury to one of the conductors by an enemy's shell; as the mains will be still connected at the ends to the dynamo, and the circuit will not be broken. By joining the circuits at the fore and aft switchboards, even the total severing of one pair of the conductors leading to the main switchboard would not cause the extinction of any lamp. Moreover, the orlop-decks, where the chief engines of war are situated, being supplied either by accumulators or the dynamos, their illumination can be cut off only by the destruction of the decks themselves.

Digitized by Google

A COMPARISON BETWEEN THE CONTINENTAL, AMERICAN, AND ENGLISH DYNAMO-ELECTRIC MACHINERY.

BY ALBION T. SNELL.

(Continued from page 6.)

The Miot dynamo and motor, made by the firm of Messrs. Mégy, Echeverria, and Bazan, are also abnormal. This is at once apparent on reference to Fig. 9. A shunt-wound generator and a series motor, constructed on these lines, were used to drive the Pont Roulant in the Machine Gallery. The object of this peculiar distribution of the pole-pieces is not clear. Indeed, this arrangement causes inequality of magnetism in the armature core. This is proved by the fact that two brushes are coupled in parallel between those pairs of poles which are farthest apart. The effect of this is to short-circuit, or render inoperative, that portion of the winding between these brushes, so reducing the output of the machine without any apparent gain. The magnet shapes are costly, and the coils must be hand-wound. Probably as good, if not better, results could have been obtained by a normal four or six-pole machine of the same weight. The cost of construction would probably have been less.

Amongst the American machines shown at Paris, there were several constructions which are not in general practice here. These are usually found in connection with arc dynamos. The enormous practice American engineers have had in this branch

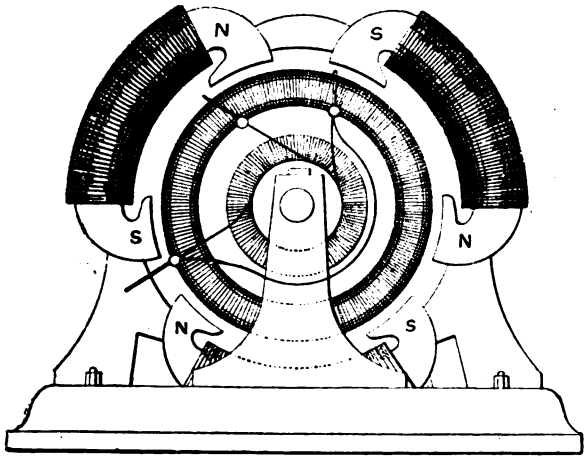


Fig. 9.—The Miot Dynamo.

of lighting has led to a variety of designs based on both open-coil and closed-coil armatures. All of these machines are arranged, I believe, with well-saturated fields and considerable self-induction. The old Brush dynamo still stands in no little favour. The Thomson-Houston dynamo has become so common with us as to excite but little curiosity; yet who can give an intelligible explanation of its wonderful performance? The Sperry arc dynamo is not so well known on our side. This machine has both internal and external pole-pieces, arranged with a cylinder armature with the ordinary Gramme winding. It really is a two-pole machine, the poles close together being of the same sign. A cross-section is shown in Fig. 10. Whether this complicated and apparently wasteful construction is necessary to obtain an equal distribution of E.M.F. in the armature coils appears somewhat doubtful. At any rate, the machine runs well, and regulates quickly, without "hunting" or excessive sparking. The regulation is made by shifting the brushes. These may be rocked through 90deg. till the dynamo ceases to excite. The regulator details are somewhat complicated, and apparently would require a good deal of attention. This form of constant-current regulation is adopted by several other American firms.

On the Continent and in England the same method of regulation is used with success. But the fields are generally the normal two-pole or multipolar type, and the armatures are simply large cylinders with Gramme windings (a few have drum windings). Messrs. Statter and Co. have given a deal of attention to this form of constant-current dynamo with success. I believe no firms, other than the Brush and Thomson-Houston, are building open-coil armatures for arc lighting. It is difficult to form an opinion as to the relative advantages of the open and closed-coil windings. There are not wanting, however, those who think the closed-coil will prove the "fittest" in the struggle for existence. Probably, also, experience alone will show whether the best regulation can be made by the variable lead or the shunted-field method. Since the constant-current systems of transmitting energy are steadily gaining ground for certain classes of work, we may expect considerable alterations in this class of dynamo-electric machinery before long.

So far the comparisons have been chiefly confined to dynamos. I will now refer to some of the motors. In Great Britain and Ireland the use of motors is so limited that few of our engineers have any really extended experience of electrical transmission of power. In the Exhibition, however, within ten hours' run of London, there have been, till recently, several very complete central stations for distributing power, and one or two sufficiently large to convince the most credulous that electrical transmission of power is an accomplished fact. The quantity of energy transmitted is only limited by the usual *commercial* and not *electrical* difficulties. If it would pay to localise 10,000 B.-H.-P. at any spot, it could be done.

The motors best known in England are the Immisch, Elwell-Parker, Crompton, Mather and Platt, &c., and there is no need to do more than refer to them. The Continental and American machines, however, are better known to most of us by repute than actual experience. The Exhibition contained some really

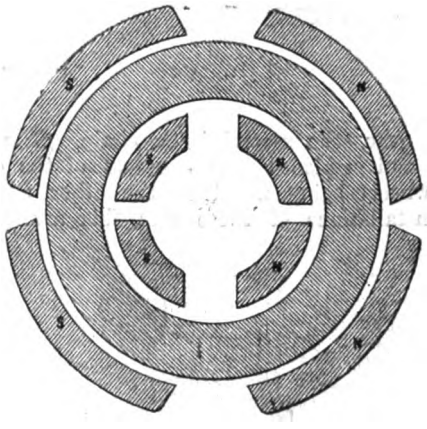


Fig. 10.—Cross-section of Armature and Field-Magnets of Sperry Dynamo.

very fine illustrations of several of these systems. The motor which has attained the greatest success on the Continent is, perhaps, the "Oerlikon." These excellent machines, designed by Mr. A. E. L. Brown, are made with two poles for the smaller types, and with multipolar fields for the larger sizes. The armatures are cylindrical, with Gramme windings. The largest direct-current motor yet built by the firm is, I believe, rated at 300 B.-H.-P. Readers of the technical Press during the past year or two will recollect the notices of several plants installed by the Oerlikon Company. I can only say that the machines at Paris fully answered to the high expectations raised by these descriptions. La Compagnie pour la Transmission de la Force par l'Électricité showed several motors, amongst others a 60 horse-power machine of the Marcel-Deprez double armature type. The transmission is effected at 1,000 volts. I have already referred to this type of machine when used as a generator; the same remarks will apply to the motor with a further objection. If one armature broke down, the second would, most likely, be useless for its share of the load without special gearing. The Compagnie Gramme had an interesting collection of motors. The modern type, so-called, has a vertical single magnet with the yoke cast in the bed-plate. There is nothing very special, however, in any of these smaller exhibits. The machines are all similar to one or other of the designs in common use in Great Britain. Perhaps the most noticeable feature was the number of motors

Digitized by Google

shown. This would seem to suggest that Continental engineers expect an extended use of motors for industrial purposes in the immediate future. Mention has already been made of the curious Miot motor, which ran the overhead traveller in the machine hall. The Julien Electric Tramway Company, of Brussels, showed one of their tramcars and also a motor truck equipped with a single horizontal magnet Gramme motor. The gearing comprises two transmissions. The first is made by toothed gear, the second by a chain. The truck has four wheels and is placed near one end of the car, a pair of rolling wheels being fitted at the other end. In the American installations of these cars this arrangement has been altered. Some of the cars are fitted with two four-wheeled bogies, each equipped with a motor: other cars have only a four-wheeled truck. The workmanship and execution of details seem, generally speaking, not so well carried out as in those motor trucks of American origin. Indeed, as was to be expected, the United States exhibits for the transmission of power show evident signs of large experience. The Sprague motor truck (Fig. 11), familiar to us all by the technical notices, is well worthy of criticism, for there are probably more electric tramcars run on this system than on any other. Hitherto these cars have been chiefly run on the direct system at a difference of potential of about 400 volts. The trucks have four wheels, and each pair is driven by a motor rated at 8 horse-power. The gearing is made in two transmissions, both being cut spur-wheels. The high-speed pinion on the motor shaft is cut on a built-up blank of red vulcanised fibre. This gearing runs almost noiselessly, and is said to wear as well as cast steel. Probably the relatively soft fibre springs sufficiently to always engage two if not three teeth, and hence back-lash, and consequently the wear is reduced to a minimum.

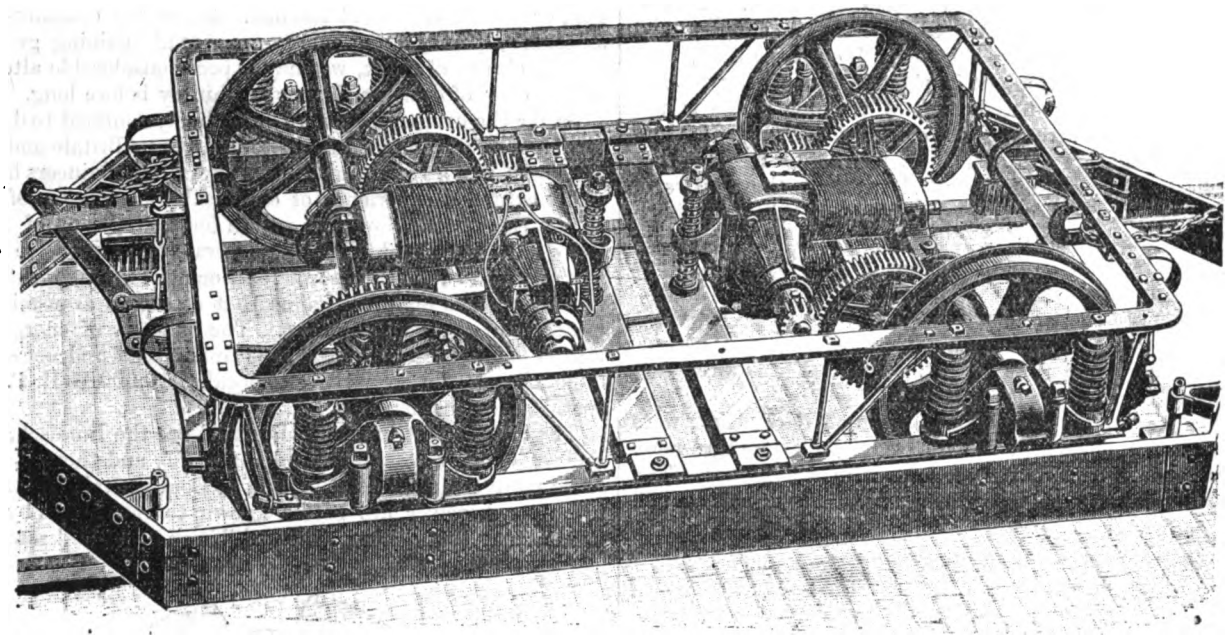


Fig. 11.—Sprague Motor Truck.

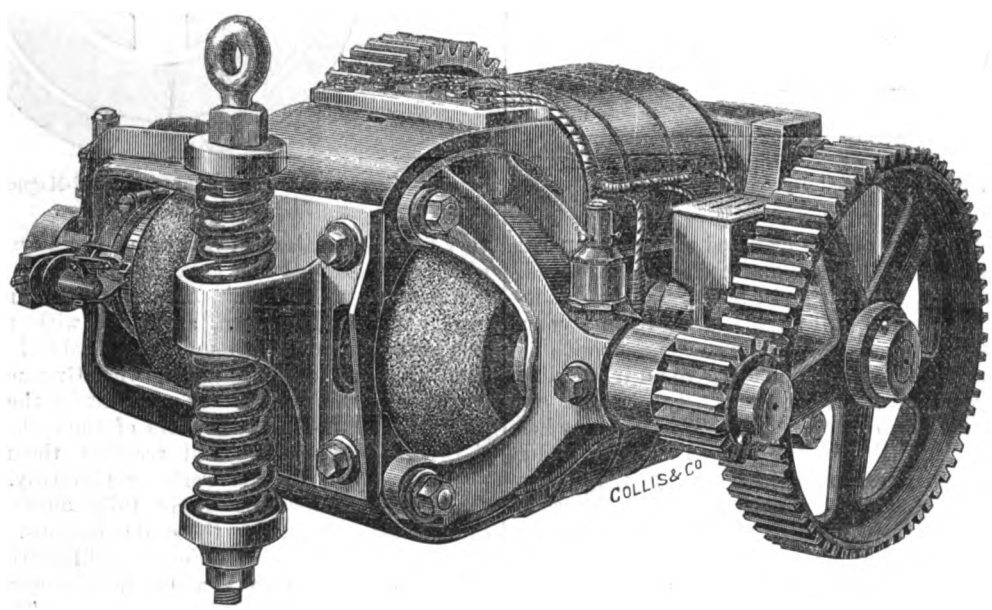


Fig. 12.—Sprague Street-Railway Motor.

The motor (Fig. 12) is of the horizontal single magnet type, with a drum armature. The speed is regulated by altering the coupling of the field windings. The brushes are blocks of ordinary battery carbon, placed in suitable holders, at an angle of about 40deg. to the horizontal (Fig. 13). The direction of motion is controlled by the switch.

There is, of course, room for criticism of most of these details. I have referred at length to the method of starting the motor

Digitized by Google

without resistance in *The Electrician* of August 31, 1888, and November 30, 1888. The advisability of using a drum armature for so high a tension as 400 volts, in such an exposed position as a tram truck, is also open to doubt, and the gearing may be called in question. But there can be no two opinions about the excellence of the workmanship and the thoroughness with which all the details of the design are thought out. The method of insulating the armature wire is novel. The iron core is first coated with a black waterproof varnish, and then covered with indiarubber,

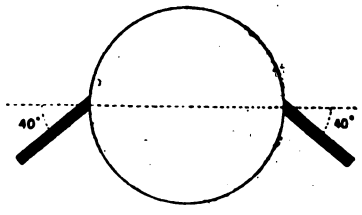


Fig. 13.

which is vulcanised in position. The cotton-covered copper wire is also coated with a varnish said to be completely water-proof. One form of the switch arrangement is as follows:—A circular switch-box, somewhat similar in design to the Julien accumulator switch, is placed under the car flooring between the two axles. This is coupled to the two motors, so that they are both controlled by the same movement. A circular motion, from the position of rest, starts the motors in the one direction or the other, according as the handle is rotated to the right or the left. This main switch is connected by rods to a lever and quadrant at either end of the car, similar to that in use on locomotive valve gears. A forward motion starts the car forward, a backward movement reverses, and the vertical position stops the motors.

The Thomson-Houston Company had a 50 horse-power transmission plant. Both dynamo and motor are designed on the single magnet type, with the yoke cast in the bed (Fig. 14). The armatures are drum wound. The compound

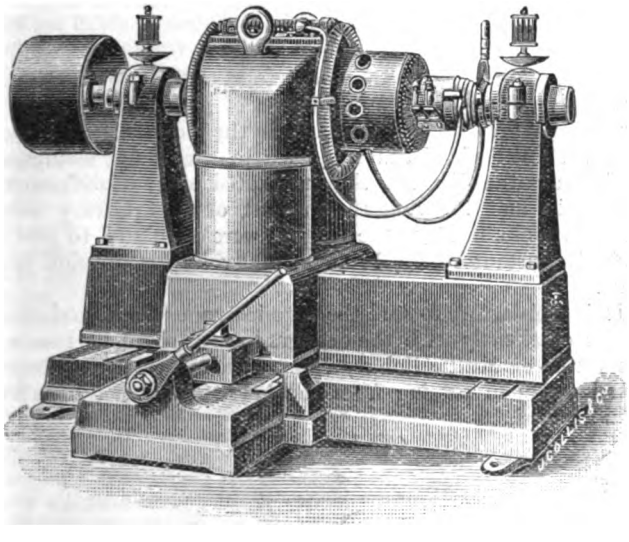


Fig. 14.—Thomson-Houston Dynamo for the Transmission of Power.

coil around the armature is not used in the motor. The E.M.F. at the dynamo is about 500 volts. This company had also some well-designed motor trucks, with gearing similar to the Sprague. The Sperry Company showed an electric coal digger (*Electrician*, July 5, 1889). The motor is a small machine of about 2 horse-power, of the single magnet type. The only special feature is the brush gear. The brushes are of carbon and lie with their points normal to the surface of the commutator. It is worthy of note that the use of battery carbon for motor brushes is steadily gaining ground.

(To be continued.)

SIR WILLIAM THOMSON'S CHAIN OF ELECTROSTATIC VOLTMETERS.

BY ANDREW W. MEIKLE, M.A.

(Continued from page 31.)

The Vertical Scale Voltmeter.

The arrangement of the parts of this instrument will be readily understood from an inspection of the cut given in Fig. 8. The first portion of the condenser is formed by two vertical brass plates of the shape shown in the illustration. These are supported from the back of the metal case by two vulcanite knobs, and are fixed to each other by two cylindrical distance pieces, so as to be accurately parallel. The plates thus, as will be seen, form two quadrant-shaped cells, similar to those of the multicellular, but much larger in size, and having the space between them quite free from obstruction, except at the two corners, where they are bound together by the distance pieces. The centre of the plates has a circular opening through which a brass arm with bearing plates and V guides passes from the back of the case. The movable portion is an aluminium vane, which rests on knife-edges on these bearing plates, and is kept in

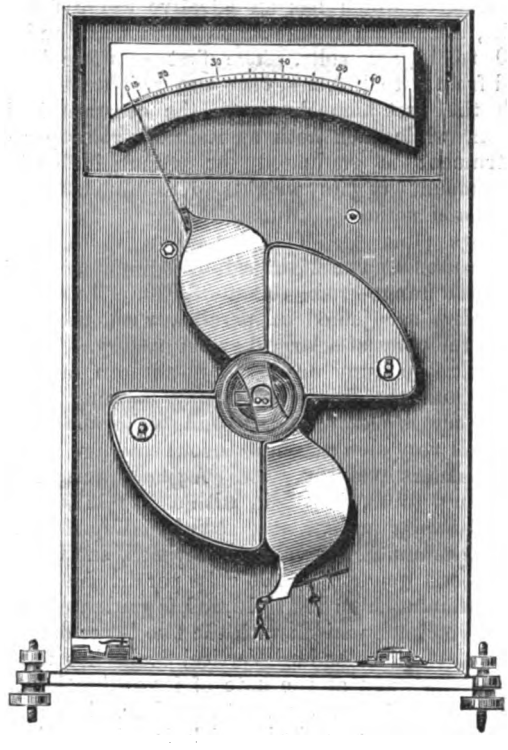


Fig. 8.—The Vertical Scale Voltmeter.

position by the V's, so that it is free to turn in a plane midway between and parallel to the fixed plates. The upper end of the vane carries a pointer, which indicates the deflections on the scale of the instrument, while to the lower extremity is fixed a knife-edge for weights, with its length perpendicular to the plane of the plate. The vane is adjusted to be in a state of neutral equilibrium by two sensibility screws, which turn one on a vertical and the other on a horizontal arm attached to the lower end of the vane. The shape of the vane has been somewhat changed lately, and, as a result, the scale has much larger divisions than in the earlier instruments.

The following improvements have also to be noted, which greatly increase the portability of the instrument. Two small guard-rings, passing over the knife-edges, are attached to the bearing plates, so that the movable plate cannot be displaced so as to make contact with the fixed portions. In order to prevent damage to the pointer the range of motion of the vane is limited by two stop pins fixed into the back of the case. The left-hand stop is divided at half its length into two portions, one of which screws into the other. When

Digitized by Google

the instrument is packed for carriage, the outer half of this stop is passed through a small hole in the top of the vane, and then screwed firmly into its position. When thus packed the vane is lifted from its bearings, and its knife-edges are held in two slots cut in the guard-rings. In this way the instrument is rendered very portable, and easily adjusted when set up for use.

In the two types of the instrument usually made the scale is graduated from 0 to 60, and the divisions represent equal differences of potential—the actual value of the difference per division being dependent upon the particular weight in use at the time. A set of three weights is supplied with each instrument, providing for three grades of measurement in the proportion of 1 : 2 : 4. The constant is 50 volts per division with the smallest weight on, 100 volts per division with the first and second weights on, and 200 volts per division with all three weights on.

Standardising the Vertical Scale Electrostatic Voltmeters.

The Vertical Scale Electrostatic Voltmeters are usually graduated by direct comparison with standard instruments. In addition to the series of Multicellular Voltmeters, three instruments of the vertical type are kept for that purpose, the first of which has an effective range from 250 to 3,000 volts, the second from 400 to 8,000 volts, and the third from 800 to 12,000 volts. The first of these has a scale graduated from 0 to 150, and only two weights are used, such that with the first alone hung on the constant is 10 volts per division, while with both on it is 20 volts per division. This instrument is graduated throughout its entire scale, and the amount of its weights determined by using a Volta pile and series of Multicellulars in the manner described above (Fig. 6). This low-range Vertical Scale, A, can then be used to check the calibration of the next instrument, B, with range from 400 to 8,000. To do this, the two voltmeters are joined in parallel, with their terminals attached to the poles of a large Leyden battery. The first and second weights are hung on A, so that it can measure up to 3,000 volts, and the first weight only is hung on B. The Leyden battery is then charged, and while the potential is allowed to fall very slowly, simultaneous readings are taken on the two voltmeters every 50 volts. A graduation of B is thus obtained from 0 to 60, such that, with a certain weight on, the constant is 50 volts per division, then by using four times this weight the constant is 100 volts per division, and by using four times the second weight it is 200 volts per division. The third standard, with range from 800 to 12,000, is graduated in a similar manner by direct comparison with the two lower ones.

The second of the standard Vertical Scales has now been in use for some time, and at the date of its calibration the chain of Multicellular Voltmeters was not complete. It was therefore graduated by another method, which is still employed as a check on the present system. The calibration of its scale was obtained as follows:—The instrument was joined in parallel with an auxiliary voltmeter, and their terminals attached to the two poles of the Leyden battery mentioned above. The battery was then charged to such a potential that the auxiliary instrument, X, gave a reading at a definite mark on the most sensitive part of its scale, and a weight of convenient amount was hung on the instrument being standardised, Y, so that it gave a deflection of about half its available range. The potential of the Leyden battery was kept constant by observing the indications on X, and the weights on Y were varied so as to satisfy the condition $d \times \sqrt{W} = K$, where d is the point on the scale which it is wished to obtain, W is the weight hung on the knife-edge, and K is a constant. For example, suppose it were agreed to call the point where the indicator stood with the first weight hung on 30, and the amount of the weight were 400 milligrammes, then the division 60 would be obtained by hanging on a weight of 100 milligrammes; while the weight to give the point for division 15 would be 1600, and that for division 20 would be 900 milligrammes. Thus a scale was obtained graduated from 0 to 60, and, as the force of attraction between the movable and fixed plates of the instrument varies as the square of the difference of potential between them, the divisions represent equal differences of potential.

In order to find the proper weight to make this scale read 100 volts per division, a known difference of potential was multiplied by charging a number of condensers in series, and the voltmeter was used to measure the total voltage between the extreme terminals of the condenser pile. This method of multiplying potential was described by Sir William Thomson at the Aberdeen meeting of the British Association. A diagram of the arrangement is shown in Fig. 9. The difference of potential between the terminals TT' of the standard resistance is known as explained above with reference to Fig. 4 by the indications of a standard centi-ampere balance. The condensers, 16 in number, are joined in series and wires brought from their terminals to commutator bars fitted on to a vulcanite disc; a movable arm actuated by a handle and bearing two brushes can be made to revolve round the circumference of the disc so that the brushes are only in connection with two contiguous bars at one time. Wires pass from the terminals TT' to two spring contacts in connection with the revolving brushes. The movable arm is made to revolve very rapidly, and by this means each condenser is charged in the same direction and each has the same difference of potential between its terminals. The difference of potential between the extreme terminals of the series will then be 16 times that between the terminals TT' of the standard resistance. The insulation of the condensers must, of course, be very high to obtain good results by this method, but as an additional check a Multicellular Voltmeter was applied in succession to the terminal of each condenser and the sum of the readings on it was taken as the total difference of potential between the extreme terminals of the series. It was found that the number so obtained

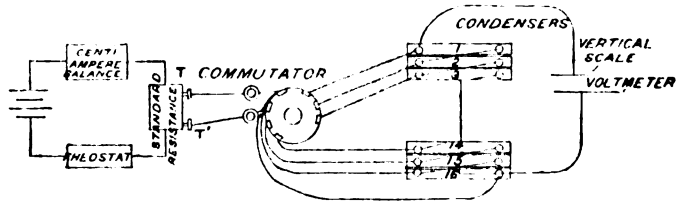


Fig. 9.

differed by about three volts on a total of 2,200 from that got by simply multiplying the difference of potential between the terminals of the standard resistance by the number of condensers. The Vertical Scale Voltmeter joined to the pile of condensers, as shown in the diagram, thus measured a known difference of potential; and knowing the amount of an arbitrary weight hung on its knife-edges, the weights were calculated to give the desired constant of 50, 100, and 200 volts for division of its scale.

It is satisfactory to find that the instrument so standardised agrees excellently with the one graduated by comparison with the series of Multicellulars, a fact which shows that observational errors in passing from the lower to higher ranges have been avoided.

(To be continued.)

SOME PECULIARITIES OF ALTERNATE CURRENTS.*

BY W. E. SUMPNER, D.Sc.

Alternating currents are not by any means new, although it is only lately that they have become of great importance in engineering work. The dynamos first made yielded alternating currents because, as they needed no commutator, they were simpler to construct. They were not adopted, partly because continuous currents were easier to understand and to use, and partly because direct-current dynamos could be made self-exciting. Alternators came to be looked upon as antique types which had yielded place to the more perfect direct-current machines. However, the currents used outside the dynamo, although direct, were, of course,

* Presidential Address to the City Guilds Old Students' Association, November 19, 1889.

Digitized by Google

result of rectifying, by means of a commutator, the alternating currents produced in the armature by its own revolutions. All dynamos, therefore, produce alternating currents in the first instance; and in the same way all motors, before they will work at all, must be fed with alternating currents, whether a commutator is introduced to produce these alternations or not. The action of all machines used for the production of currents depends on the properties of magnetic change discovered by Faraday. The currents induced depend on the rate at which the magnetism varies, and alter in direction as it decreases or diminishes. The magnetism cannot be always changing in the same direction, so that the currents induced must be alternating. Nearly all the useful appliances of magnetism result not so much from magnetism itself as from the alteration of it. This is the case, for instance, in telegraphy and telephony, in which we are always using varying or alternate currents. If I pass an alternate current through one of the coils of this transformer, we hear it singing. The current in the coil induces magnetism in the iron, and this changes in direction every time the current alternates. The magnetism acts on the windings of the coil, causing attractions which vary in amount with the strength of current, and it also causes in the iron itself stresses and strains which alter at every reversal of current. Vibrations are therefore set up, which give rise to a note of a pitch corresponding with the frequency of the current. If due to any irregularities in driving or want of symmetry in the dynamo, the strength or frequency of the current is subject to variation; the note given out by the transformer will indicate this by altering its strength and pitch. The consequence is that the sound given out is very similar to the hum of the engine and dynamo. The transformer acts like a telephone, and, indeed, in principle a telephone is nothing more.

The first difficulty in connection with alternating currents is to settle how to measure them. They are continually varying, and therefore cannot be said to have any value in particular. If I pass the varying current produced by this commutator through an incandescent lamp, you notice that when I turn the handle slowly, the lamp varies in brightness as the strength of the current changes. If, however, I turn the handle quickly, so as to produce twenty or more alternations per second, the lamp lights quite steadily. The strength of the direct current which would make the lamp light equally well is said to be the mean value of the alternating current used. This definition seems simple enough, but it defines the value of a current with reference to its heating effect only. It is soon realised that the importance of an alternating current depends chiefly on its magnetic influence, and not to any great extent on its heating effect. With steady currents the two are proportional, and each therefore is a measure of the other. Partly due to this cause and partly owing to the false notion that the current carries energy along with it, we are liable to confuse the heating effect of a current which represents waste energy with the useful energy of the current which has no necessary connection with it, and in consequence some of the properties of alternating currents seem at first surprising. The efficiency and life of lamps seem to depend merely on the mean heating effect, for, as far as we know, they are the same for direct and alternating currents in spite of the fact that with the latter the maximum value of the current is far in excess of the mean value. With most of the practical applications of alternate currents, however, we have to bear in mind not only the strength of the currents, but also their frequency and magnetic surroundings. The currents and potentials are continually rising and falling in value. They are really waves, and have all the properties of waves.

Now one of the chief peculiarities about waves is that they do not add together in the same way that numbers do. They add together like forces. We all know that if two forces, each of 1lb., are acting on a body, the effect is not the same as that of 2lb., unless the two forces act in the same direction. According to the angle between the forces, the force equivalent to the two may vary from 2lb. to nothing. If two men are pulling at the same rope in order to ring a church bell, it is necessary for them to pull together, or one will tend to stop the bell while the other is trying to ring it. In the same way two waves flowing to the same point will add to each other's effect if their rising and falling occur at the same time; but otherwise they will interfere and diminish each other's effect so that the resultant disturbance may be less than that which either would have caused separately. It does not, therefore, follow that two alternating currents flowing into the same wire will produce a current whose strength is the sum of the strengths of the two components, and, as Lord Rayleigh* has pointed out, if a current branches into two parts, by means of two parallel circuits, it may happen that each of the branch currents is greater than the original current.

I have here the primary and secondary circuits of a Mordey transformer connected in parallel in such a way that if steady currents were flowing the coils would magnetise the iron in the same direction. In the main circuit, and also in each of the branch circuits, a Bernstein lamp is placed. When I close the circuit you notice one lamp is much brighter than the others, and the brightest lamp is in the branch circuit, not in the main. If I now disconnect one of the branch circuits the current diminishes to practically nothing, although the potential on the remaining coil actually increases. Shunting one coil with the other, therefore, not only increases the main current, but also that in the part shunted. These effects, of course, do not occur with steady currents. A somewhat similar experiment is due to Mr. Blakesley. His branch circuits consist, one of a resistance possessing self-induction, and the other of a condenser. By suitably choosing the capacity of the condenser, it is possible to increase the current through the self-induction branch, and make it exceed the current in the main circuit. Mr. Blakesley calls his arrangement a condenser transformer, and it seems to have important practical bearings.

The following experiment is due to Mr. E. W. Smith,* of the Central Institution. It is analogous to Lord Rayleigh's: potentials are dealt with instead of currents. Here is a coil having a fairly large amount of self-induction, in series with an inductionless resistance. Here are two similar lamps of large resistance shunted, one to the inductive, and the other to the non-inductive resistance. I pass the alternating current through the arrangement, and adjust the resistance till the lamps are equally bright. Each lamp now measures the difference of potential of the points to which it is shunted. I now remove the wire which connects the junction of the two lamps with the junction of the inductive and non-inductive portions. You notice that each lamp diminishes in brightness, showing that the whole potential difference is less than the sum of the two halves. By making the shunt connection again, each lamp brightens up, although Mr. Smith's experiments have shown, and theory confirms the fact, that the main current from the dynamo is diminished by so doing. By making the shunt connection, we necessarily diminish the resistance, although the potentials appear to increase and the main current to diminish, quite the opposite of what would occur with steady currents.

I have extended this experiment by forming a Wheatstone's bridge, two opposite arms of which consist of inductive resistances, the remaining arms being non-inductive. To each corner of the bridge I have attached a flexible lead coming to these lamps. The two wires attached to the corners of the bridge connected with the dynamo I have labelled red, and the remaining two, joining the parts of the bridge usually attached to the galvanometer, are labelled white. I connect the red wires to the terminals of the two lamps, the junction of which I connect successively with the white wires, adjusting in each case the corresponding non-inductive resistance till the lamps are equally bright. Each time I make connection with the white wire the lamps brighten as before. From analogy with steady currents we should now expect the bridge to be balanced, since the potential difference between either red and either white wire is the same. This, however, is not at all the case, for if I join the white wires to the extremities of the two lamps, we notice they burn almost as brightly as when joined to the red wires connected directly with the dynamo. Theory indicates that if the impedance of the inductive arm were large compared with its resistance, the potential between the white wires would be exactly equal to the potential between the red ones; and that in any case if the bridge is balanced in the way described, there will be a difference in phase between the two potentials corresponding with a quarter of a period, so that one potential difference will reach its maximum when the other is at zero. Now this is exactly the difference in phase required to drive a Tesla motor. I have here a small anchor ring of iron wound with coils in four quadrants. The coils in opposite quadrants are connected in series, so that a steady current flowing through either pair will cause a north and south pole in the adjacent quadrants. If, now, alternating currents differing in phase by a quarter of a period are sent through the two coils, each pole will move from one quadrant to the next every quarter of a period, so that the polarity will revolve round the ring with the same frequency as that of the alternating current. There is an iron disc free to revolve about the axis of the ring, and when I connect the red wires with one pair of coils and the white wires with the other, you see the disc spins round at a great velocity, and thus forms a Tesla motor. There is, however, this peculiarity about it, that only one alternating current is used. The disadvantage of a Tesla motor is that it requires two alternating currents, fixed in phase with reference to each other, so that it is necessary to have a special dynamo to produce the currents, and also to have at least three leads instead of two. Here, however, is a method of making any alternate current work a Tesla motor. Mr. Blakesley† has, I find, already suggested his condenser transformer for the same purpose. The method I have suggested is not economical, but it can be improved by having the arms of the bridge of high resistance or impedance, and having two opposite quadrants of the Tesla field-magnets wound with many turns of fine wire instead of a few turns of thick wire. Moreover, if con-

* See *Phil. Mag.*, May 1886, p. 378, and also December, 1886, p. 495.

* *The Electrician*, June 14, 1889, p. 152

† *See* the discussion on Mr. Kapp's Paper on "Alternate-Current Machinery," *Proc.* Inst. Civil Engineers, February, 1889.

Digitized by Google

densers of suitable capacity are substituted for the non-inductive arms of the bridge, the waste will be smaller, and the amplitude of the potential between the white wires will actually be greater than that between the red ones attached to the dynamo. At all events, there seems to be fair ground for supposing that some such arrangement can be found, by means of which a Tesla motor can be economically worked off any alternating current.

Striking effects of interference are obtained by putting a coil, whose impedance is large compared with its resistance, in series with a condenser of suitable capacity. If an alternating current is passed through such an arrangement, and measurements of potential are made with a quadrant electrometer used idiostatically, the potentials at the terminals of the coil or condenser are each found to far exceed the potential at the ends of the combination. Theory indicates that under the most favourable conditions the two former are equal to each other, and the ratio of either to the latter is then approximately equal to the ratio of the impedance of the coil to its resistance when this ratio is fairly large. Thus with the secondary of an induction coil having a resistance of 6000 ohms, and coefficient of self-induction 50 quadrants or secohms, and with a condenser of 0·05 microfarads capacity, calculation shows that the most favourable frequency of current to employ would be 98 periods per second, and that the potentials on the coil and condenser would then be each about five times the potential on the two in series. In the confirmation of this by actual experiment, I have had the advantage of the assistance of Messrs. Monckton, Simon, and Taylor, of the Central Institution. The field-magnets of an alternator were excited with suitable currents, so as to produce at varying speeds of the dynamo an alternating potential of about 30 volts. In the annexed table the results obtained are recorded. The number of periods per second corresponding with the speed of the dynamo is indicated in the first column. The second column gives the ratio of the potential on the induction-coil to that of the dynamo, and, of course, is equal to the square root of the ratio of the corresponding deflections. The third column gives the ratio of the potential on the condenser to that of the dynamo. The last column gives the sum of these two ratios, which, but for interference, would always be unity.

Periods per second.	Potential on coil.	Potential on condenser.	Sum of potentials.
73	1·00	1·93	2·93
82·5	1·84	2·64	4·48
102	4·38	4·14	8·52
116	3·28	2·49	5·77
120	2·91	2·06	4·97

From these numbers it is evident that the potentials on the coil and condenser will be equal when the frequency is less than 102 periods per second, and that the sum of the two potentials will be greater than 8·52 times the potential of the dynamo. When it is considered that the self-induction of the coil, which had an iron core, was measured not with rapidly alternating currents, but with a single impulsive change of current, the agreement between the theory and experiment is quite satisfactory. But although theory so perfectly accounts for the effects, it is nevertheless surprising that a difference of potential can be divided into two parts, each of which is so much greater than itself. Of course, if 20 accumulators are connected up in series with 19 others, and in opposition the potential on the whole is two volts, while those of the parts are 40 and 38 respectively; and this tends to prove, what is practically true, that the alternating potentials are in opposite phase, but the peculiarity with alternating currents is that the potentials of the two parts may be exactly equal, while that of the whole is neither the sum of the two nor the zero difference.

What is really happening in these cases of interference is illustrated by an experiment on pulsations which I am able to perform by means of an ingeniously-contrived commutator kindly lent me by Mr. H. B. Bourne. Alternate bars of the commutator are connected together, and to the two ends of a battery of cells. There are two brushes, one fixed and the other movable, so that as the commutator revolves, one brush may be made to move over the bars more rapidly than the other. Each of these brushes is connected with the middle of the battery through the primary of a transformer. As the commutator revolves, an alternating current comes off from each brush. The period will be the same if the brushes are both fixed, and the phase may be altered by moving one brush with reference to the other. If one brush revolves slowly, the two alternating currents are of slightly different period. The two secondaries of the transformers are connected in series with themselves and with an incandescent lamp. The brightness of the lamp measures the sum of the two currents induced in the secondaries by the alternating currents in the primaries. If the currents coincide in phase, the lamp burns brightly; while if the phase of the currents is opposite, as I can arrange by suitably fixing the movable brush, the lamp is extinguished. If I now revolve the movable brush slowly, the phase of the currents is continually altering, and you see the lamp slowly pulsating in brightness. Although the two alternating currents induced in the secondaries are always of the same strength, yet their sum varies from zero to double the value of each, according to the phase of one with respect to the other.

After all, however, the most extraordinary property of alternating currents is that which has been longest known, viz., their tendency to transfer themselves from one circuit to another with which they have apparently no connection. The appearance of these induced currents is accompanied not by a decrease, but by an increase of the primary current. The primary and secondary currents increase together. The explanation is that the currents are in nearly opposite phase, and one current is neutralising the magnetising effect of the other. The magnetism caused by alternating currents always tends to a minimum, and the currents have to arrange themselves so that their joint magnetising effect may be as small as possible. This tendency is very marked at high speeds, and the compensation is almost perfect. The little magnetism remaining is, however, very important, because of its extremely rapid rate of variation. The induced electromotive forces depend on this rate of variation, and not on the maximum amount of magnetism. Thus, in transformers there is a strong tendency for the primary and secondary currents to be in opposite phase. [This is the explanation of a simple but important experiment due to Mr. Mordey, and the fact was proved by a large number of experiments of Messrs. C. G. Lamb and E. W. Smith made at this college some time ago.*] The strength of the currents in the coils also arrange themselves to be nearly in inverse proportion to the number of turns, for this is the condition that the magnetising effects should be equal. There is also a tendency for the magnetism to alter itself in the simplest way possible, and this is according to the law of sines. The secondary currents, therefore, tend to follow the law of sines because they exactly follow the variations of magnetism. The primary current will also follow the law of sines if the magnetism is proportional to the current, but, if saturation is approached, calculations I have made from experimental data show that the primary current may depart very much from a simple sine wave, as will also be the case if the electromotive force acting on the primary is itself irregular. The tendency of magnetic change to a minimum is exemplified in the action of choking coils and in the heating of iron cores. If an opposite current can be induced in neighbouring circuit or bodies so as to cancel the magnetising effect, the primary current is allowed to flow, but otherwise the reluctance of the magnetism to change suddenly will prevent the current rising to any magnitude. The same tendency occurs within the wire itself, for the adjacent portions of the current tend to flow in opposite directions. The tendency to reverse currents is strongest in the centre of the wire, and consequently the current density is less there than near the surface. The resistance of the conductor is increased by this, and the alteration is very important when the wires are thick and the alternations of the current are very frequent; as, for instance, in the thick-wire circuit of electric welders. Thick leads are, therefore, not well suited to alternating currents; but, on the other hand, they are rarely necessary, for, by means of transformers, large amounts of energy can be efficiently transmitted immense distances by means of inexpensive thin wires.

It is not, however, only in engineering practice that alternate currents have become of great importance. Within the last year or so the theory of electricity has been advanced tremendously by the study of alternating currents. We have seen that with rapid alternations the currents are determined chiefly by the magnetic changes which are going on, and that they arrange themselves as far as possible to neutralise each other's magnetic effect without much apparent regard to the electromotive forces acting, or the resistances in circuit. This tends to show that the most important part of an electric current is not in the wire itself, but in the region outside. It has been by considering the changes going on in the medium outside the wire that Hertz has been able to experimentally prove the existence of effects which have hitherto only had a mathematical basis. If a current is reversed in direction, the lines of force surrounding it are also reversed. Maxwell's theory, however, states that they do not reverse instantly. The lines of force near the wire reverse before the others. There is a certain velocity at which the reversal of the lines travels, and this velocity, according to theory, should be about the same as the velocity of light. That this is actually the case is one of the things which Hertz has lately shown. In order to do so, he has made use of rapidly alternating currents. He has also employed a detector whose great delicacy is due to the principle of resonance, which may be illustrated by an experiment of Prof. Ayrton's,† which I have arranged. An alternating current is passing along this stretched

* See discussion on Mr. Kapp's Paper on "Alternate-Current Transformers," *Jour.* Soc. Tel. Eng., Feb. 23, 1883. Also see a note of Profs. Ayrton and Perry on "The Lag in Transformers," in *The Electrician* for March 16 1888.

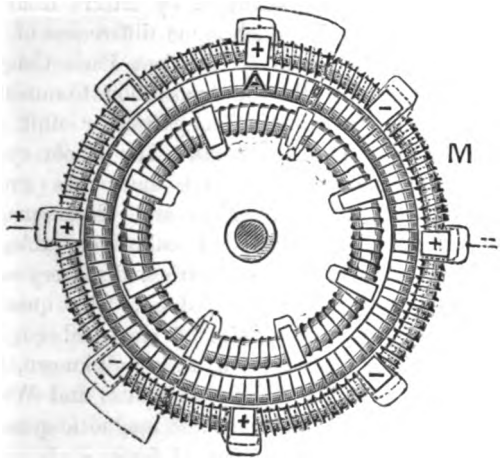
† See *The Electrician*, July 5, 1889, p. 221.

Digitized by Google

wire. When I hold a magnet near, the wire is pulled aside owing to the mutual action of the current and the magnet's lines of force. Every time the current reverses, the direction of the pull on the wire reverses, so that the wire is put into a state of vibration. The loudness of the sound, however, depends on the length of the stretched portion of the wire. There is one length which will give the best effect, and this happens when the wire is tuned to give out a note of the same pitch as that corresponding with the frequency of the alternating current. The current in any case forces the wire to give out a particular note, but if the wire naturally gives out that note, the sound produced is much greater. The interference of potentials occurring when an induction coil is placed in series with a condenser, is another instance of resonance, for the condition that the potential on the coil should be greatest compared with the whole potential acting on coil and condenser, can also be shown to be the condition that the natural period of oscillatory discharge of the condenser into the coil coincides with the period of the alternating current. It has been by using this principle of resonance that Hertz has been able to detect, in the medium outside the wire, cases of interference with magnetic reversals, exactly similar to those I have shown you with alternating currents and potentials. His work has opened up an endless field of discovery, and these results have been brought about by making use of the peculiarities of alternating currents.

VAN DEPOELE ALTERNATE-CURRENT INDUCTION MOTOR.*

The illustration below shows the principles of the construction of an alternate-current induction motor recently invented by Chas. J. Van Depoele, of Lynn, Mass. The conductors and connections upon the field-magnet system are so arranged that alternate polar extensions will be magnetised by the main supply current flowing through proper conductors. The remaining polar extensions are magnetised by conductors arranged in secondary relation to the



Van Depoele Alternate-Current Induction Motor.

main field-magnet conductors. It will thus be seen that only a single circuit in the machine is supplied with currents from the source, the remaining or other effects being produced by induction. As indicated in the drawing, the armature A is provided with a large number of closed circuits, wound upon a laminated iron core. It is closely enveloped by the polar extensions, which are cut away in the figure for convenience of illustration. Magnetising conductors, M, are wound upon the cores, and when traversed by currents of alternating polarity, the magnetism in the pole-pieces will be reversed. The iron entering into the construction of the cores and pole pieces, being laminated, permits the field-magnets to respond to the reversals in the supply current with the desired degree of rapidity.

Under the influence of an alternating current the action of a field-magnet such as described arranged in inductive proximity to an armature having a number of closed circuits thereon would of itself have little or no effect, since the action of the field-magnets would be merely to create local currents in the closed circuits, which, though polarising the armature core, would accomplish nothing. By the present device, however, the poles created in the armature core by the inductive action of the field-magnets are caused to produce rotation of the armature by a second set of polar extensions arranged to react upon the poles as the energy that created them dies down in the main field-magnets. Such an arrangement takes the form of fixed magnets arranged upon the interior of the armature as indicated. The action of the machine is as follows: A primary phase of current rising in the main field-magnet coils will magnetise the polar extensions, and the lines of force from the pole passing through the armature conductor in proximity thereto will create secondary currents in the armature conductors. These secondary currents will establish definite poles in the armature core, which will be of opposite sign to that of the polar extensions by which they were created. The same phase of primary current by which the armature core was magnetised, as just described, will also produce secondary currents in the secondary field-magnet conductors, and as the primary phase dies in the primary circuit, the secondary currents created thereby will bring the secondary pole-pieces to their maximum magnetic strength. This will occur substantially at the same time as the poles are produced in the armature core by the secondary current, and the secondary pole-pieces being in advance of the primary pole-pieces, the armature will be attracted, and will have a definite and powerful torque, whether in motion or prevented from moving by mechanical means. The effect of the primary pole-pieces upon the core is repeated by the secondary pole-pieces, so that the phases alternating in the pole-pieces each create a current in the armature conductor. This current establishes a pole to be acted upon by the pole-piece in advance.

* From the *Western Electrician*.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

MONDAY, November 25th.

LONDON CHAMBER OF COMMERCE.

8:30 p.m. Monthly Meeting of the Committee of the Electrical Trades' Section, to receive the reply of Mr. LEE BAPTY with regard to the Edinburgh Exhibition.

LONDON INSTITUTION.

5 p.m. Lecture, "Shooting Stars." By Sir R. S. BALL, F.R.S

SOCIETY OF ARTS.

8 p.m. CANTOR LECTURE I. 1. "Modern Developments of Bread-Making." By WILLIAM JAGO.

TUESDAY, November 26th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be further discussed, "Water-Tube Steam Boilers for Marine Engines." By Mr. JOHN J. THORNYCROFT, M.Inst.C.E.

ROYAL VICTORIA HALL.

8:30 p.m. Lecture, "Greenland's Icy Mountains." By J. E MARR.

WEDNESDAY, November 27th.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. "Scientific and Technical Instruction in Elementary Schools." By J. HALL GLADSTONE, Ph.D.

THURSDAY, November 28th.

LONDON INSTITUTION.

6 p.m. Lecture: "Mithridates and the Scorpion." By Prof. RAY LANKESTER, M.A.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. Paper to be read, "Electrical Engineering in America." By G. L. ADDENBROOKE, Associate.

FRIDAY, November 29th.

INSTITUTION OF CIVIL ENGINEERS.

7:30 p.m. Students' Meeting. Paper to be read, "Principles of Iron Foundry Practice." By G. H. SHEFFIELD Stud.Inst.C.E.

ELECTRO-HARMONIC SOCIETY.

8 p.m. Meeting at St. James's Hall Restaurant, Regent Street. (Ladies' night.

*** Particulars of meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.

Digitized by Google

The Electrician.

Published every Friday. Price Fourpence; Post Free, Fourpence Halfpenny.
Editorial, Publishing and Printing Offices:

No. 1, SALISBURY COURT, FLEET STREET, LONDON, E.C.

Telephone No. 2714. *Telegrams:* "ELECTRICIAN NEWSPAPER, LONDON."

All Communications to be addressed to "THE ELECTRICIAN," *1, Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN."

All letters intended for insertion in "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. Subscribers should receive their copies by the first post on Friday morning.*

"THE ELECTRICIAN" *is on sale at the railway bookstalls throughout the United Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices as above.*

SPECIAL NOTICE.

Owing to the increase in the number of pages of "THE ELECTRICIAN," in order to partly cover the increased postage, we have been compelled to revise the rates for Foreign Subscriptions, which are now as follows:—

	3 months.	6 months.	12 months
For Foreign Parts and Colonies:—	s. d.	s. d.	s. d.
Within Postal Union	6 6	12 6	24 0
Aden, Borneo, Ceylon, China, India, Japan, Java, Labuan, Mozambique, New Caledonia, Persia, Philippine Islands, Siam, Transvaal, and Zanzibar	7 6	14 6	28 0
The rates for the United Kingdom remain as follows:—	5 0	10 0	19 6

TO ADVERTISERS.

"THE ELECTRICIAN" *offers exceptional advantages to Advertisers.* **It has the largest circulation of any English Elec rical paper, and circulates all over the World.**

Particulars relating to Advertisements will be promptly forwarded on application to the office.

TRADE ADVERTISEMENTS *intended for the current issue must be handed in not later than First Post on Thursday morning.*

SMALL PREPAID ADVERTISEMENTS *(for Rates see page xiii.) are accepted up to 4:30 p.m. on Thursday.*

TECHNICAL PRINTING.

"THE ELECTRICIAN" PRINTING AND PUBLISHING COMPANY (LIMITED) *beg to inform Electricians, Electric Light Engineers, &c., that they make a specialty of Technical Printing, and have a Staff thoroughly acquainted with Electro-Technology. They can, therefore, promise Accuracy and Despatch in the Printing of Electrical Catalogues and Electro-Technical Literature generally.*

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.

Royal 8vo.

Early in each year is issued "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK. *The* DIRECTORY *was established in 1883, and the 1889 Edition, which is now on sale, consists of more than 600 pages of printed matter. Every care is taken to make the names and addresses of all persons engaged in the Electrical Industries absolutely accurate. Useful Tables and Electrical Formulæ are given, together with popularly-written Biographical Notices of the leading Electricians, Electrical Engineers, &c., accompanied in many cases by Portraits.*

The issue for 1890, which will be still further enlarged and improved, is in active preparation. New Names and Addresses, Corrections, Advertisements, &c., should be forwarded at once to the Publishing Office, **1,** *Salisbury-court, Fleet-street, London, E.C.*

CONTENTS OF THE CURRENT NUMBER.

NOTES 53
A Comparison between the Continental, American, and English Dynamo-Electric Machinery. By Albion T. Snell. Illustrated. Continued 57
Sir William Thomson's Chain of Electrostatic Voltmeters. By Andrew W. Meikle, M.A. Illustrated. Continued 59
Some Peculiarities of Alternate Currents. By W. E. Sumpner, D.Sc. 60
Van Depoele Alternate-Current Induction Motor. Illustrated 63
Meetings of Scientific Societies... 63
ELECTRICAL UNITS 64
Notes on Atmospheric Electricity and the Use of Sir William Thomson's Portable Electrometer. By C. Michie Smith.. 66
The Institution of Electrical Engineers—
"The Lighting of the Centennial International Exhibition, Melbourne, 1888 and 1889." By K. L. Murray, C.E. Illus. Continued ... 67
Some Methods of Regulating Accumulators in Electric Lighting. By George B. Prescott, Jun. Illustrated 69
Physical Society—
Electrification Due to the Contact of Gases with Liquids.. 73
The Siemens and Halske Transformers. Illustrated..... 73
American Notes... 74
CORRESPONDENCE—
The City and Guilds Technical Education.—W. E. Ayrton... 75
The Institution of Electrical Engineers.—"Telegraphy". 75
Electrical Inspectors.—Charles H. Yeaman 75
A Long-Lived Incandescent Lamp.—Orlo V. Thomas ... 76
LEGAL INTELLIGENCE—
The Queen *v.* Redman 76
PATENT RECORD 76
COMPANIES' MEETINGS, &c.—
The Australasian Electric Light, Power, and Storage Company (Limited) 77
City Notes, &c. 77
Companies' Share List 78

Subscriptions are received by "The Electrician" Printing and Publishing Company for all Continental and American Electrical Journals. Subscription Rates on application to "THE PUBLISHER." *Remittance must accompany order* IN ALL CASES.

ELECTRICAL UNITS.

Our columns were lately occupied by letters from highly esteemed correspondents, in which some differences of opinion were expressed on the action of the last Paris Congress of Electricians, and of the British Association Committee on electrical standards, in adopting a particular unit of self-induction and calling it a *quadrant*. The whole system of modern electrical nomenclature and units has grown up out of the application of galvanism and electro-magnetism to telegraphy, and particularly to submarine telegraphy; and the enormous rate at which electrical discovery now progresses is, in a very high degree, due to this quantitative measurement which the necessities of electrical engineering called into existence. This system, as is well known, is based on the absolute dynamical system of GAUSS and WEBER, in which the measurement of electrical and magnetic quantities is made to depend on the measurement of force, work, or power, and is, therefore, made ultimately referable to the fundamental standards of mass, length, and time. In building up a logical system of electric units on this absolute system, in terms of the centimetre, gramme, and second, we are first of all met by the difficulty that the absolute electric units are either too large or too small for practical use. The absolute unit of electromotive force, based on the Gaussian definition of a unit magnetic pole, is one hundred million times smaller than the average electromotive force of a Daniell's cell, and the unit of current on the same system is some ten times greater than the currents taken by a 50-volt 16-candle incandescent lamp. The first step in rendering this system convenient for practical use is to multiply or divide the magnitudes of these C.-G.-S. units by powers of 10, and obtain the units which were called by the British Association Committee the *practical units*. We arrive thus at a definition of what ought to be the magnitudes of the electrical units, which are suitable for use. The next step involves us in greater difficulty.

Digitized by Google

These ideal units have to be rendered concrete, and the standards embodied in a material form, or in a definite physical process, to be of practical use. The unit of resistance required in a workshop is not a mere definition of unit, but a piece of wire which possesses the quality of electrical resistance in a known and definite degree. The statement of the manner in which the unit of electric current is to be defined, as depending upon the magnitude of the force between a certain current in a certain conductor and a particular magnetic pole, also defined by its dynamical relation to other similar poles, is a statement which is perfectly devoid of utility to anyone desirous of measuring the current produced by a given dynamo under fixed circumstances. In this matter we find ourselves placed in much the same position as we are in the question of standards of length. A metre may be defined to be the ten-millionth part of the quadrant of a meridian; but we can make no use of this statement until the metre is embodied in a material rod or bar. If, then, it had been at once possible to translate these definitions of what the electrical units ought to be, on the most convenient system, into actual material standards or processes, so perfect, so exact, and so permanent that no delectable deviation from their ideal values ever existed, we should have been at once in possession of a system of electrical units theoretically complete and practically useful. The relations of the various magnitudes to each other would have been, in reality, that required by theory to subsist. Unfortunately, however, this is not the case. The experimental difficulties surrounding the determination in absolute value of the magnitude of various electrical quantities have only been gradually cleared away; and even the permanence of the material standards themselves has had to be the subject of experiment and doubt. We find ourselves, therefore, in the position that the actual standards which must be the means of reference are not the same in value as those ideal standards which are required to be materialised. Hence the practical units, taking this term to mean the convenient multiples or sub-multiples of the absolute units, are not identical with the most highly probable absolute values of the practically used units, or material standards or actual processes. It is evident that as long as this is the case, confusion is created by the use of the term "practical" to describe both the ideal units and their concrete representations. The term practical ought most naturally to be applied to that which is used in practice, and the phrase "practical unit," if it means anything at all, means the unit which is used in practice, and not that which it was intended the unit should represent.

In a Paper read before the British Association at Manchester in 1851, the late Sir CHARLES BRIGHT and Mr. LATIMER CLARK laid the foundations of that system of nomenclature in which the appropriate multiple or sub-multiple of the absolute unit was christened by a short name derived from the surname of some illustrious investigator. Hence the names Ohm, Volt, Farad, now so familiar, were originally each applied to the ideal unit, which is some decimal power of the absolute unit, based on the system which is built up on the Gaussian definition of a magnetic pole, and on the unit of electric current, which is determined by the electro-magnetic quality of the current. In process of time it was found that the standard resistance coils, which were originally constructed by the British Association Committee to be the concrete representation of the ohm, fell short of the ideal magnitude by about 1·3 per cent. Accordingly, these resistances, often called British Association units of resistance, and the countless copies of them which existed, came to be regarded as very imperfect realisations of the ohm. The 1884 Congress of Electricians in Paris decided that a more approximate representation of the ohm would be obtained by accepting as the material standard of resistance the electrical resistance of a column of pure mercury at 0° Cent., having a length of 106 centimetres, and a cross-section of one square millimetre. There are many who now think that this decision is to be regretted, and that the interests of practical science would have been better served by waiting until a better consensus of opinion had been obtained on the absolute value of the British Association unit, and such as would have enabled a standard to be constructed representing with the greatest probability of accuracy the ideal ohm. As it is, neither the British Association unit nor the Paris Congress unit are anything more than arbitrary standards of resistance, approximating in value to that ideal resistance which is called the ohm. Hence have arisen such qualifying phrases as "Legal Ohm," and "British Association Ohm." There is no one, however, we think, who would deny that the term ohm should properly be applied to a unit of resistance which is one thousand million times the absolute unit of resistance on the electro-magnetic system employing the centimetre, gramme, and second, as fundamental units.

We have now, apparently, reached the point when the close attention to phenomena of self-induction is bearing its natural fruit, and rendering necessary quantitative work on this subject. Hence arises a need for a unit of self-induction, and for a name for it. The candidates for the post of honour are apparently the *secohm* and the *quadrant*. The secohm has been first in the field. The quadrant has the weight of authority at its back. Moreover, there seems to be a difference between them. Prof. AYRTON contends, and we think rightly so, that the practically used unit of self-induction must be one which is connected with the practically used unit of resistance and electromotive force by a relation given by the well-known equation for the value of the current flowing at any instant in an inductive circuit under a constant electromotive force. Hence, if we *measure* resistance in so-called legal ohms and electromotive force in corresponding legal volts, the unit of self-induction must be of such a magnitude to correspond with these; and if we understand his letter of October 11 rightly, the secohm is intended to be this unit. We might here remark that it follows, as an obvious consequence, that if anyone measures resistance in British Association units, or old ohms, and electromotive force in the corresponding units, they will be under the logical necessity of employing a unit of self-induction which is not the secohm as employed by its originators. The Paris Congress and the British Association Committee have apparently taken the view that the practical unit of self-induction (in the original sense of the term practical) should be the unit correlated to the true or ideal unit of resistance, viz., to the ohm as it was originally intended to be. There can be no doubt that if the terms Ohm, Volt, Farad, &c., are to signify, as they were intended to do, the practically convenient multiples of the absolute units, the practical unit of self-induction which is to fit in with this system, *and to be named*, must be one which is correlated to the true ohm and true volt, and not to the approximate representation of them which, under the names legal ohm or British Association unit, continue to be used until replaced by standards having a better claim to represent the ideal units. To put it more briefly, if the word ohm is to be taken as signifying an electrical resistance of which the dimensions are 10^9 centimetres per second, and if this is the practical standard of resistance in the original sense of the word practical, then the practical unit of self-induction must be one of which the dimensions are 10^9 centimetres. The practically used unit of self-induction will, however, be one which is correlated to the practically used unit

Digitized by Google

of resistance, be this the legal ohm, British Association unit, or any other. The next question which arises is, whether the Committee have done well in christening this unit by a name which evidently has reference to certain ideas concerning the dimensions of the unit. This is not the place to enter into a discussion on the theory of dimensions. We believe that when further research has enabled us to take the dynamical qualities of the electro-magnetic medium properly into account in forming the fundamental equations, the whole of the present mode of regarding the dimensions of electrical quantities will be modified. Meanwhile, we rather question the wisdom of affixing a dimension-suggesting name to any electrical unit. Is it not rather departing from the original idea that the names of the unit should be simply distinctive sounds abbreviated preferably from the names of men? Nor are we very much in love with "secohm" as a name. We do not call a coulomb a sec-ampere or sec-amp, and the once used term of volt-ampere gave way immediately at the suggestion of the late Sir W. SIEMENS to call it a *watt*. We would have preferred to have seen the matter arranged as follows:—Let a short name, preferably the abbreviation of the cognomen of some illustrious electrician, be affixed to that unit of self-induction which on the present system of measurement has a dimension of 10^9 centimetres. Hence this unit is systematic with, and correlated to, the true ohm, true volt, &c. Then, as in the case of the ohm, prefix the adjective "legal" or "practical" to denote the practically used unit. This is what, we presume, the Congress and Committee have desired to accomplish. The Quadrant is the practical unit, but measurements of self-induction which are made with resistance boxes of legal ohms, and stop-watches giving mean solar seconds, give the result in legal quadrants, and are reduced to centimetres by multiplication by a factor, of which the highly probable value is $\cdot 9977 \times 10^9$.

Whether results of measurements are expressed in secohms or quadrants, it will evidently be necessary for the user of these terms, for some time to come, to define what he means by them. The practical man can base the whole of his electrical measurements on an ohm, an ampere, and a second, and provided we have defined once for all what is *the* standard of actual resistance, and what is *the* actual process by which an ampere is recovered, all the measurements of practical work can be conducted with perfect success and consistency. There are occasions when the necessity for knowing the most highly probable absolute values of the practically used unit arises, but for industrial purposes the most important fact is that, given a unit of resistance defined and distributed in the form of a coil of wire, and given a definition of an ampere in terms of the amount of silver deposited by it under definite circumstances, the whole of the essential practically used units can be recovered by any competent person. We do not think that the measurement of self-induction has become such a frequent workshop operation as to make the selection of a name for its unit an important question; but, meanwhile, two bodies of authority have adopted the term *quadrant*, and it is sufficiently intelligible to be understood, even though there may be, as we have shown, some objections to it. As a matter of fact, whenever measurement of self-induction does become a workshop operation, it will certainly be effected by comparison with a material standard of self-induction, and this will have to be calibrated consistently with the practically used standard of resistance.

Besides the mere question of a name for this unit of self-induction, our correspondence has opened up other matters on which opinions evidently differ, and these we will consider on another occasion

NOTES ON ATMOSPHERIC ELECTRICITY AND THE USE OF SIR WILLIAM THOMSON'S PORTABLE ELECTROMETER.*

BY C. MICHIE SMITH.

At the Aberdeen meeting of the Association, Sir William Thomson communicated a Paper of mine on the general conditions of atmospheric electricity in Madras.† Since then I have continued the observations, and have fully confirmed the conclusions arrived at, that while in Madras, as elsewhere, the most common fine-weather electrification of the air is positive, the normal condition during dry, hot, dust-laden winds is that the air shows a negative potential. To-day I wish to call attention to one or two special observations. In Madras, at certain seasons of the year, we frequently have magnificent displays of sheet lightning, night after night, and I have often made electrometer observations from the roof of the house while these displays were in progress. In some cases an evident effect was produced on the potential of the air, but in general it was found that the electrification was normal. This points to a conclusion which I long ago arrived at, that so-called sheet lightning may be clearly divided into two classes. There is, what all recognise, the reflection of distant lightning seen on the clouds or on the sky, but there is also—and it can easily be distinguished from the former—a series of discharges going on between two neighbouring masses of cloud. These discharges often take the brush form; at other times fine flashes may be seen lighting up the whole mass of the cloud, and at times a large series of discharges, almost parallel and simultaneous, pass betwen the two cloud banks.

Such discharges taking place at a considerable distance do not sensibly affect the electrometer. On the other hand, when the sheet lightning is simply the reflection from distant flashes, the electrometer is usually strongly influenced. I have been able during a violent storm at a distance to draw actual sparks from the wire carrying the burning match. That clouds, or at least masses of mist, vary greatly in potential in different parts I have found by actual measurement. In one case I found on the Neilgherries, at a height of about 7,300 feet, that the mist as it drove past was partly positive and partly negative. The subject of the electrification of mists deserves a much closer study than it has yet received.

When in Japan last June I took a series of electrical observations during the ascent and descent of the active volcano of Asamayama, and though the results are almost purely negative, they may have some interest. I will not trouble the Section with the detailed observations, but the general result was that during the ascent the readings were all positive except one, and varied from + 45½ div. at the lowest point to + 137 at the edge of the crater. The one negative reading was got near the foot of the cinder cone and was − 54 div. It seemed to be due to a mass of cumulus cloud overhead, apparently formed from steam from the crater. At the top the electrification, both at 1·35 p.m. when I reached, and at 3·5 p.m. when I left, was strongly positive. Steam was ascending all the time, but not very vigorously. During the descent the readings were all positive, varying from 147 at the top to 53 near the foot of the cinder cone. On another occasion I took a series of readings in crossing the Wada Pass. These were remarkable from their lowness; all were positive or nil, being 0, 0, + 17, + 5, and at the top (5,300ft.) + 17. I then climbed to the top of a hill some 400ft. higher, standing well clear of the rest of the hills, when the reading was + 100 div. On the descent on the Suwa side readings of + 3, + 17, and + 31 were obtained.

It has been suggested that a few words on the use of the portable electrometer in damp, tropical climates might be valuable. From my own experience of thirteen years I find that the instrument must be treated very differently from what is necessary in this country, and that the observer must be content with much less complete insulation. In the first place the pumice must be charged with a much larger quantity of

* Paper read before the British Association in Section A, Newcastle-on-Tyne, September, 1889.

† *Phil. Mag.*, Nov., 1885, p. 456.

‡ 1 div. = 4 volts approximately.

Digitized by Google

acid—as much as it will absorb without showing a moist surface. This, of course, involves more frequent drying. I find that about a fortnight is long enough to leave it. The greatest difficulty, however, is in charging the instrument at all. It is almost hopeless to attempt it with the small electrophorus supplied with it, and even when an electrical machine of any kind is used the greatest care is required in drying the charging rod. A ring of ebonite round the charging hole facilitates the operation, and the rod should be removed by means of a piece of warm silk. Recharging will be necessary every three or four days, and a positive charge is best. These remarks may seem superfluous, but I find that the neglect of such simple precautions as I have indicated has been the cause of leading many people to think that the use of the portable electrometer in India is impossible. Perhaps some idea of the difficulties involved will be gathered from the fact that on very few days can a Voss or Wimshurst machine be got to work till it has been thoroughly toasted, and that if it is working when the wind is westerly it instantly ceases to work when the sea-breeze comes on.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

"The Lighting of the Centennial International Exhibition, Melbourne, 1888 and 1889."*

BY K. L. MURRAY, C.E.

(Continued from page 40.)

In all efficiency tests but one, Siemens' electro-dynamometers were used to measure the current. For some other tests Ayrton and Perry's meters, of both spring and magnet forms, were used. The values of the readings of these instruments were carefully determined by comparison with the electro-dynamometers. The latter instrument was calibrated by connecting it in series with a battery, an adjustable resistance, and a fixed resistance consisting of a large number of small German silver wires arranged so that any number could be put in parallel. The massive terminals to which the small German silver wires were fastened were connected through a very sensitive reflecting galvanometer and a standard Clark cell. A key was, of course, placed in each circuit. With a given number of German silver wires in parallel, the current through the total circuit was adjusted by means of the variable resistance till the potential difference at the terminals of the German silver wires was equal to the electromotive force of the standard cell. The exact resistance of the German silver wires was immediately measured by the aid of one of Elliot's metre bridges. A small standard resistance was constructed from a piece of the same German silver wire as that used in the fixed resistance. The exact value of this coil was found by comparison with one of Elliot's standard B.A. units. All apparatus to be used was placed in position some time before required, to allow the temperature of all parts to become equal. The temperature was taken by a standard thermometer which had been tested at the Kew Observatory. Two standard cells were used —one by Latimer Clark, Muirhead, and Co., the other made up at the time in accordance with Lord Rayleigh's instructions, whose formula for the variation of the electromotive force of the cell with change of temperature was used. The two cells when tested were found to be almost exactly equal. No difference could be detected when they were compared by the condenser and ballistic galvanometer. But a very small difference did exist, and was shown by the deflection on a sensitive reflecting galvanometer when the cells were connected zinc to zinc, the remaining terminals being connected to the galvanometer. In all calibrations some measurements were taken with each of the standard cells. The results of the calibration tests of the Siemens' electro-dynamometer gave the value of the constant = ·8716. The constant, as given by the maker, was ·87—a difference of less than one-fifth per cent. The same electro-dynamometer, when compared with one of Ayrton and Perry's latest spring ammeters, differed by very little more than ·01 per cent. Two voltmeters were used —one of Ayrton and Perry's spring form, the other of the electro-dynamometer pattern. Both of these instruments were wound with copper wire, and large resistance coils of German silver wire, differentially wound, were used to reduce the potential difference at the terminals of the instrument proper. The voltmeters were calibrated in exactly the same manner as the current meters. They were also checked by measuring the potential difference at the terminals of a known resistance by means of the condenser and ballistic galvanometer. These two methods gave exactly the same results in several tests, and the condenser method was ultimately discontinued, owing to the difficulty of obtaining a place where the ballistic galvanometer could be used without interference from locomotives moving in the vicinity. The dynamometer voltmeter was afterwards compared with one of Ayrton and Perry's spring meters: for 100 volts the difference in their readings did not exceed one-tenth of a volt. The meter-bridge was calibrated by Carey Foster's well-known method. An additional correction had to be made for the heating of the gauge wire by conduction from the binding screws. No special means were previously employed to prevent error from this source, as it was not anticipated that the effect would be appreciable.

The selection of a suitable mechanical dynamometer was not easy. The following conditions were laid down as essential:—1. It must be susceptible of a fair degree of accuracy, and show instantly any variation in the load. 2. It should be of such a form that errors are not likely to arise from the difficulty (owing to the thickness of the belt) of accurately determining the virtual radius of the pulley; and no power should be absorbed between the point at which the pressure is measured and the dynamo spindle. 3. Any springs contained must be so placed that centrifugal force will not introduce uncertain effects on the indications of the instrument. 4. It must be portable and easily fitted up. The first condition simply requires that whatever the principle involved it shall be faithfully executed, and that the moment of inertia and number of moving parts shall be as small as possible. The second condition requires that the power shall be transmitted to the spindle of the dynamo at some fixed distance from its axis of rotation, and that it is the pressure at this point which is shown on the indicating mechanism.

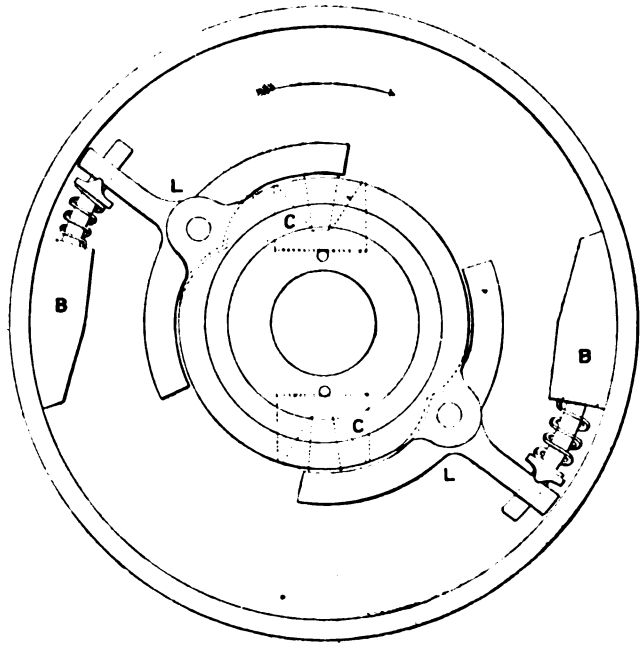


FIG. 1.

The simplest way of fulfilling the above conditions seemed to be to give the dynamometer the form of a pulley to be directly applied to the spindle of the machine tested. It is important that the displacement of any of the parts of the mechanism shall be very small, even though the indicator passes from zero to its maximum reading. A pulley was accordingly constructed the principle of which is as follows:—The energy supplied to the machine is transmitted through a fixed point at a distance intermediate between the axis of the spindle and rim of the pulley. By means of levers and pistons the pressure is transmitted to a fluid filling the chamber in which the piston moves, and by it through a glass tube which lies in the axis of rotation to a spring chamber, the capacity of which varies with the pressure on the enclosed fluid. The pressure on the point through which the energy is transmitted is shown by the displacement of the fluid in the glass tube.

The pulley (*see* Figs. 1 and 2) was made so that the rim R could turn freely on the nave N. Two radial chambers, C, were carefully bored in the nave at the opposite ends of a diameter, and pistons were accurately fitted in them, so that though watertight they could move freely. Two bent levers, L, were hinged at the nave, each being so shaped that when one arm pressed on the centre of the piston, the line passing through this point of contact and the centre of the hinge was at right angles to the radius drawn through the point of contact. At the same time the other arms of the levers

* Paper read before the Institution of Electrical Engineers, November 14, 1889.

Digitized by Google

TABLE A.—EFFICIENCY OF BRUSH ARC DYNAMOS (No. 7L), HOT.

Description of Machine.		Maker's Number.		Mechanical Data.			Electrical Data.			Commercial Efficiency.	
		Machine.	Armature.	Time of Run.	Revolutions per Minute.	H.-P. absorbed at Pulley.	Current in amperes.	At Terminals.			Mean.
								P.D. in volts.	E.H.P.		
				Hr. Min.						%	%
Solid Frame.—Armature Plates ...	Thin.	457	N.T.A. 149	3 11	930	17·64	9·396	1,149·5	14·47	82	
		924	N.T.A. 146	3 48	930	20·16	9·899	1,247·7	16·55	81·9	
		454	N.T.A. 143	3 24	935	21·43	9·705	1,234·9	16·07	74·9	78·7
		460	157	3 0	930	22·89	10·1	1,220	16·52	72·17	
		462	...	3 0	930	19·95	9·731	1,261	16·46	82·56	
	Thick.	467	N.T.A. 184	3 35	930	23·34	9·861	1,232	16·28	69·75	69·75
Rail Pattern.—Armature Plates ...	Thin.	1846	158	2 33	928 6	23·18	9·988	1,292·7	17·31	74·7	
		1840	152	3 20	932	18·99	9·783	1,197·4	15·74	82·8	77·43
		1849	161	3 20	930·6	24·66	10·001	1,376·9	18·45	74·81	
	Thick.	1843	N.T.A. 188	3 30	924·5	23·08	10·089	1,251·6	16·92	73·31	
		1861	172	3 27	735	18·99	9·265	1,033	12·83	67·56	69·84
		1856	167	3 0	917	26·8	10·129	1,350·6	18·34	68·65	

stood in a direction such that the surface of the lever remote from the piston coincided with the radius passing through the centre of the hinge. These arms were of such length that they just cleared the inner surface of the pulley rim. The connection between the rim and nave was made by means of two blocks of iron, B, riveted to the inner surface of the rim in such a position that they would come in contact with the projecting arms of the levers. The point of pressure was rendered definite by the use of knife edges, and any shock was relieved by the interposition of a suitable spring. Two small holes were drilled parallel to the eye of the pulley opening into the cylinders. The indicating apparatus was fixed so that it would coincide with the axis of rotation when the pulley was in use. It consisted of a glass tube, with a carefully fitted ebonite piston which served as a marker. This piston was made about ten diameters long, and had several small grooves turned in it. The glass tube was mounted with a metallic chamber at each end, one being bolted to the pulley nave, the other closed with a circular

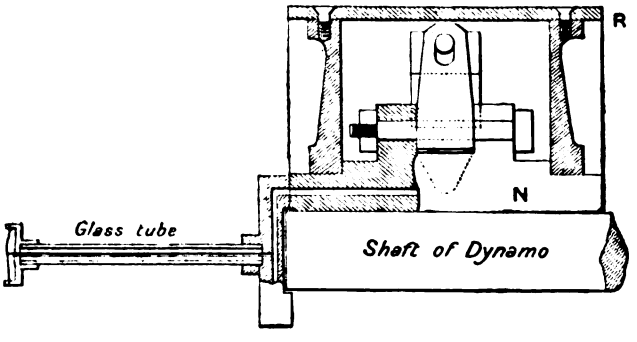


Fig. 2.

corrugated steel spring similar to those used in some steam pressure gauges. The metallic chambers were mechanically connected by an iron tube in which three longitudinal slots were cut to enable the glass tube to be seen. The angular width of each slot was 60deg. The scale was fastened on the inner side of the bars of the iron tube, consequently each time a slot turned towards the eye the glass tube and ebonite piston were seen projected on the scale that was fastened to the opposite bar. When in rapid motion the scale appeared as if drawn round the glass tube, and the end of the black ebonite piston formed a well-defined line from which to read. Every tenth division was marked in red, and the fifties were shown by a bright line on the outer surface of the iron tube. In the pulley used the diameter of the bore in the glass tube was about $\frac{1}{25}$th of that of either piston. Hence, if both pistons were in use, the motion of the ebonite piston would be about 1,250 times as great as that of either of the main pistons. The length of the scale was about 6·5 inches, so that a motion of the main pistons of $\frac{1}{200}$th of an inch would cause the indicator to travel over the whole length of the scale. The pullley was arranged so that one or both pistons could be used. By this means the range of the instrument was doubled. Using one piston and running at 900 revolutions per minute, the maximum reading corresponded to about 30 horse-power, and with both pistons to about double that value. It will be seen that a dynamometer of this form may be constructed to fulfil fairly well the conditions laid down as essential. The sensitiveness is determined by the stiffness of the steel spring and length of glass tube used. In practice a very great degree of sensitiveness is not required, as the variations in the power absorbed were found to exceed two, or at times even three per cent. of the total, whereas one-half per cent. could have been easily read. The ammeter showed fluctuations in the current at least equal in relative magnitude to those shown by this mechanical dynamometer.

To calibrate the dynamometer pulley it was keyed on a fixed horizontal spindle. A long balanced arm was bolted to the rim, and at a distance from the centre of the spindle (measured horizontally) equal to $\frac{20}{2\pi}$ feet a screw was put into the lever. Various weights were suspended from the screw, and the corresponding displacement of the ebonite piston noted. It was found that the displacement was directly proportional to the load; hence the scale could be so divided that the readings would show at a glance the tangential pull of the belt in pounds at any given radius. In the pulley used the constant was calculated for a radius of $\frac{10}{2\pi}$ feet. The reading showed at once the tangential pull at this radius, and multiplying by ten, the number of foot-pounds absorbed per revolution of the armature. It should be noted here that the levers in the pulley were counterbalanced for the centrifugal force of the pistons and fluid below them. The correctness of the balancing was tested by mounting the pulley on a spindle and rotating it rapidly in both directions, first of all having removed the rim. If the balancing were correct a small deflection should be produced, its direction depending on the direction of rotation, and the two deflections should be equal at the same speed of rotation. No error was detected owing to the unequal distribution of the fluid pressure on the circular spring caused by centrifugal force. This fact is not surprising when it is remembered that the effective diameter of the spring was only 1·25 inches, and that the fluid (glycerine) used was light. The dynamometer pulley was placed on the machine which it was desired to test, in the daytime, and fresh glycerine put in. One of the bolts holding the field-magnet core was taken out, and a similar one, but with a hole bored in it to receive the thermometer, put in its place.

The electro-dynamometers were always carefully adjusted for position after all machines were in full work, so that no disturbing effect would be introduced by the action of the current in leads which ran near the testing table. Each reading noted gave the mean position of the indicator for about 15 or 20 seconds in all measurements, whether electrical or mechanical. The speed of the armatures was determined by one of Harding's counters, in all cases a full minute being taken. The constants of all electrical instruments were calculated for the mean temperature of the dynamo room—27° Centigrade. The temperature correction for the dynamometer pulley was not determined, as only the first or last two or three readings were to be used in the results, and the accuracy of these were ensured by taking the zero of the pulley both before and after the machine was run. The intermediate readings were taken only to show if any serious alterations took place in the general working of the machines.

These tests, the results of which are tabulated (*see* Table A), were made primarily to ascertain the commercial efficiency of the various arc machines used. By "commercial efficiency" I mean the ratio of the electrical energy available at the terminals to the actual energy absorbed at the spindle of the machine. It will be seen that the current actually supplied by the majority of the machines was a little below the normal, the machines being professedly designed for a current of 10 amperes. The times of run as shown in the table were not sufficient for the machines to attain their state of steady temperature, though in

Digitized by Google

the majority of cases the temperature reached would be a fair average for ordinary working. The armatures of the machines were interchangeable, so that any given armature cannot be considered a part of any specified machine; it was important, therefore, to ascertain not only the relative value of the different forms of frame, but also of the different armatures in them. It will be seen from the table that the different forms of machine having thin-plate armatures are almost equally efficient, the solid-frame pattern having a slight advantage. The difference, however, between the two forms of machine with thick-plate armatures is still less, and the advantage in favour of the rail pattern. But as only one of the solid-frame machines contained a thick-plate armature the comparison is of little value. For practical purposes it may be said that the commercial efficiency of the two forms of machine, provided the armatures are similar, is the same. Greater alterations in the efficiency of either class may be caused by slight alterations in the conditions of working than the actual difference between the two classes, as shown in the table. The difference in the two types of armatures is very marked. Taking the mean from the two classes of machines, the efficiency of the thin-plate armatures will be found to be about 8·27 per cent. greater than that of the thick-plate armatures. But, unfortunately, the thin-plate armatures were not calculated to withstand the mechanical strains to which they are subjected in ordinary work, so the higher efficiency obtained from them has only a theoretical existence. There is, however, no mechanical reason why the armatures should not be constructed with thin plates, and at the same time be free from the mechanical faults shown to exist in those under review. Indeed, such armatures have been constructed in the Victorian Railways Telegraph workshops, which are quite free from the faults named. One of these has been running for several years without ever giving trouble, and doing excellent work.

(To be continued.)

SOME METHODS OF REGULATING ACCUMULATORS IN ELECTRIC LIGHTING.*

BY GEO. B. PRESCOTT, JUN.

In preparing the following Paper, the limited scope of which is indicated by its title, I have assumed that it is generally conceded that the modern electric accumulator is an apparatus capable of performing a peculiar but useful function in the art of electric lighting as now commercially practised, and that it is free from defects which would render it unsuitable for such application. Indeed, I am sure that every careful observer has noted in the somewhat slow evolution of the accumulator that structural improvement and adaptation to practical requirements which unquestionably show that it has come to stay, and will acknowledge that even as it exists to-day, the accumulator is a factor in electrical industry too important to be ignored by those who take a broad view of the situation. It is not my intention to refer to those numerous successful applications of accumulators to the propulsion of small marine vessels and land vehicles, to car lighting and other minor work where the continuous generation of power from the combustion of fuel would be impracticable; neither can I fully discuss their characteristic actions under working conditions within the limits of this Paper. Although there is reason for believing that some of the early promoters of business enterprises based on the manufacture of electrical accumulators anticipated that the accumulator systems of lighting were destined to compete with and perhaps supersede many direct systems, I believe that the more mature modern idea is that they are, for the present at least, mainly subsidiary to other electric lighting systems. As auxiliaries to many direct systems, accumulators undoubtedly effect a reduction in running expenses, and add an element of reliability. In order to fully appreciate the truth of these statements it is necessary to glance at the conditions commonly existing in ordinary isolated and central station plants as they are operated at the present time. Every one who is familiar with the electric lighting business is acquainted with the vagaries of the load curves during each 24 hours of a central station's run. It is a truism to say that the cost of fuel per horse-power increases inversely as the power plant operates below its normal capacity, and that other operating expenses are, to a considerable extent, fixed independently of the load. In view of these facts it is universally acknowledged that the operation of large power plants of any character during periods of light loads is enormously wasteful. Many have hoped that the supplying of current to small electric motors during the day would remedy the evil in lighting stations, and to some extent the expectation has been realised in manufacturing centres; but even here the unfortunate overlapping of the motor and lamp service still leaves an undesirable margin. Here, then, is a field in which accumulators may perform their special function, not in competition with direct systems, but as supplying the missing feature in the commercially successful operation of 24-hour plants of moderate size. There is no obstacle in the way of applying a sufficient number of accumulators to a plant of the character mentioned, to maintain the light load during the time it would not pay to operate the power plant, and to provide for the charging of the accumulators during the regular running time of the dynamos. Assuming, in illustration of this statement that 10 hours is the ordinary working day, and that the engines of a central lighting station are started at 2 p.m., and are operated until midnight, it is probable, if not certain, that there will be sufficient surplus current for an ample length of time to charge enough accumulators for the service required after the engines cease to revolve, excluding, of course, the period of maximum load, when the dynamos will be taxed to their full capacity in their regular service. Under such conditions the engines could be operated at somewhere near their normal capacity during the whole period of their running time, and the cost of unit power would be a minimum, while only one staff of men will be required. It may be advisable to explain here that although the current available for charging the batteries during the regular running time of the dynamos would vary with the lamp load, this is of no importance, as it is not essential that the batteries should be charged at a uniform rate. In the case of such stations as also supply arc lights, the engines could be started later and operated through the night. Besides reducing the operating expenses of a station during its periods of light load to a greater extent than they increase them at other times, in the event of an accident to the power plant or incandescent dynamos, the accumulators can always be called upon for extra service; while whenever there is an abnormally heavy demand for current they may also be operated in conjunction with the dynamos. But there is still another field in which accumulators may be employed to equal advantage, viz., that of long-distance lighting now so successfully occupied by the alternator-converter system. Indeed, I can only account for the fact that accumulators were not long since more extensively used for this class of lighting, except by the existence of a feeling of scepticism as to their durability, together with their somewhat formidable first cost.

One of the commonest, and perhaps the simplest, applications of accumulators to lighting work is found in their employment in connection with direct isolated plants in factories, office buildings, &c. In illustration of the method of applying accumulators in such cases, we may select as a type of this class of lighting one of those office buildings common in New York and other large cities. This building, we may assume, has already been, or is about to be, wired for 500 16-candle, 100-volt, ½-ampere lamps on the multiple arc plan, and is to be provided with a 125-volt, 200-ampere dynamo; it being calculated that more than 400 lamps will rarely be lighted simultaneously. We are not specially concerned with the power plant, and will simply assume that it is of ample capacity, it being remembered that such buildings are usually steam heated, and, therefore, offer favourable conditions for the operation of a plant of the character under consideration. Now, it can be deduced from experience that during the day, from, say, 9 o'clock in the morning until about sunset, only a limited number of lights will be burned in certain dark corners of the building, and that as twilight and darkness come on the load will gradually increase, reaching a maximum at a certain hour depending upon the season; subsequently the load will decrease, finally reaching a minimum after the janitor and his assistants have finished their cleaning operations, which load will probably be maintained for the remainder of the 24 hours. It is evident that a direct plant operating under such conditions would necessitate the employment of two forces of men, either one or two in each, and would, moreover, be running under exceedingly uneconomical conditions for a large part of the time. Let us now consider in what manner accumulators may be added to this plant in order that it may supply the variable load for 24 hours daily, while at the same time dispensing with the services of one staff of men and reduce the running time of the engine to eight hours. It has been shown in a general way how the load varies during 24 hours; but, in order to ascertain the capacity of the accumulators required, it will be necessary to assume, though only approximately, somewhat more precise figures. Say that the load is as follows:—

From 9 p.m. to 9 a.m.,	20 lamps	= 120	ampere-hours,
„ 9 a.m. to 4 p.m.,	200 „	= 700	„
„ 4 p.m. to 6 p.m.,	400 „	= 400	„
„ 6 p.m. to 9 p.m.,	50 „	= 75	„

An inspection of the above schedule shows that for 12 hours out of the 24 only 20 lamps, or 10 amperes, are used, while for three hours more only 50 lamps, or 25 amperes, are required; and a simple calculation proves that a set of accumulators having a capacity of 200 ampere-hours will be amply sufficient to maintain the light lamp load for 14 hours out of the 24. If the dynamo is started at 8 a.m. and operated until 6 p.m., while maintaining the required number

* Paper read before the American Institute of Electrical Engineers, New York, October 29, 1889.

Digitized by Google

of lamps during that period, it will still have surplus current for charging the battery as follows :—

From 8 a.m. to 9 a.m., 190 amperes for 1 hour,
„ 9 a.m. to 4 p.m., 100 „ 7 hours,

or 890 ampere-hours, an available capacity vastly in excess of the requirements. Now, if during the eight hours in which the dynamo is operating the accumulators are charged at the rate of 30 amperes, in that period they will receive a total charge of 240 ampere-hours. According to the schedule, the maximum output required from the battery will be 185 ampere-hours, whence it follows that the charge received by it is more than ample, even after making the customary allowance of 20 per cent. for loss by conversion ; and the desired result has been accomplished.

We have now to consider the details pertaining to the practical arrangements of such an installation. According to the stipulated schedule, after the dynamo ceases to run at 6 p.m., the battery alone must supply 25 amperes for three hours, and thereafter 10 amperes for 11 hours, or a total output of 185 ampere-hours. One series of 50 cells, having, say, a normal capacity of 30 amperes for eight hours, will satisfy these requirements, and will be well within the nominal rating of ordinary commercial cells. Assuming that these 50 cells, connected in series, have been suitably placed on insulated shelving at any convenient distance from the dynamo, they may be electrically connected with the latter and with the lamp circuit, so that they will supply current to the lamp circuits in exactly the same manner as would two dynamos connected in parallel. This method does not, in fact, satisfactorily permit of that splitting of the dynamo current between the lamps and battery which was incidentally referred to. More than this, it fails to provide a means of compensating for that rise and fall of the potential of the battery during charge and discharge which has been mentioned. How, then, will it be possible to employ the higher pressure demanded by the battery and at the same time supply current to a number of lower voltage lamps without raising their candle-power above normal ? The answer is easily given, for it is only necessary to insert a suitable resistance in the main between the dynamo and lamp circuits in order to accomplish the desired

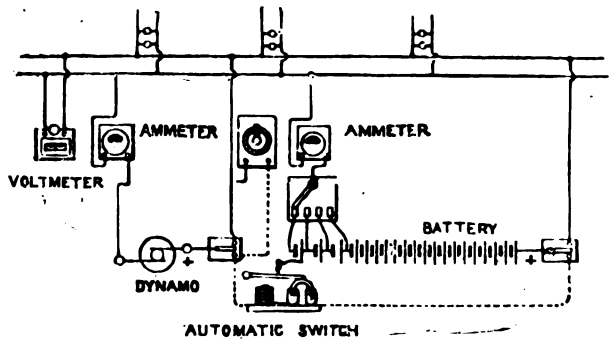


FIG. 1

result. Such a resistance, usually called a "pressure equaliser," should be made of wire sufficiently large to safely carry the current for the greatest number of lamps likely to be required at the time when the dynamo which supplies them is to be simultaneously called upon to charge the battery, and should be made conveniently adjustable, as the fall of potential through it varies with the current. The method of regulating the working potential of the battery is equally simple, for it merely consists in adding to, or subtracting from, the number of active cells in circuit. This is accomplished by means of a multiple-point switch, called a cell-regulating switch, which is so constructed that, in the act of shifting the cells in and out of circuit, it neither interrupts the circuit nor short-circuits the cells.

The method of employing the pressure equaliser and cell-regulating switch is shown in Fig. 1. The function of the automatic break switch is merely to interrupt the charging current, in the event of the potential of the dynamo becoming so much reduced from any cause as to allow the battery to overcome it, and perhaps reverse its polarity. This switch, a practical form of which is shown in Fig. 2, consists of a simple electro-magnet with a weighted armature lever carrying at one end a '∩-shaped bent wire dipping into mercury cups. The charging current passes through this magnet and from one mercury cup to the other through the bent wire. When the current becomes greatly reduced to any predetermined extent, gravity overpowers the attractive force of the magnet, its armature is released, and the bent wire being drawn out of the mercury cups, the circuit is broken. While the method of installing a single series of accumulators in connection with an isolated plant, as described and illustrated in Fig. 1, fulfills most of the conditions required in small plants operating a single dynamo, in larger plants of a similar type, using two or more dynamos, several series of the largest cells may be required. Although such an installation would consist mainly of an amplification of the system already described, still there exists a new difficulty not met with in that system. This arises from the fact already mentioned, that when several series of cells are charged in parallel, any essential difference in the amount of the residual charge in the several series results in their allowing different amounts of current to flow through them, although all of the series are charged at the same potential. The remedy for this undesirable result is of the same character as that employed to prevent excessive pressure on the lamp circuits, when the dynamo which supplies them with current is at the same time used to charge accumulators. In circuit with each series of cells is placed a small adjustable resistance coil, called a current equaliser. It is composed of wire large enough to carry the maximum current of a single series of cells, and usually has a resistance of from 3-10 to 6-10 of an ohm. Each series of cells is also provided with an ammeter, and upon the commencement of a charge the current equalisers are so adjusted that each ammeter shows the same amount of current to be passing through each series. In order to avoid as much as possible any loss of energy in the current equalisers, they are all turned to the no-resistance point at the start, and resistance is then only inserted in such series as may be taking more current than others. It may be mentioned that both the pressure and current equalisers may be made to operate automatically by the application of a potential magnet to the former and of a current magnet to the latter, together with a simple but somewhat expensive train of gears to move their levers. This is found to be wholly unnecessary in practice, however, as an engineer is usually in constant charge of such a plant, while the dynamos are running, and he can easily devote the little time necessary to the infrequent regulation required.

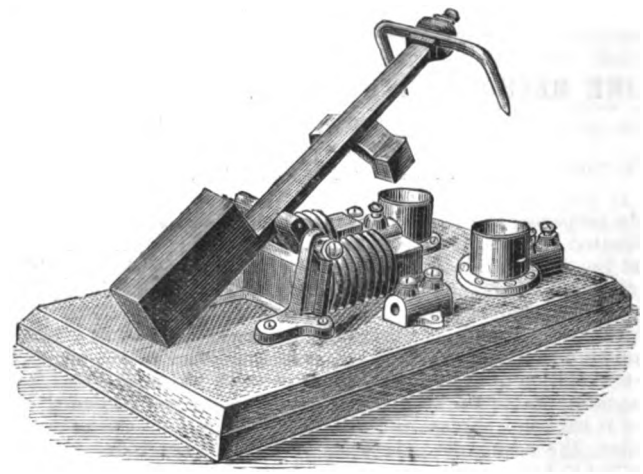


FIG. 2.

It was mentioned in the early part of this Paper that it was possible to injure accumulators either by over discharging them or working them at too high a rate. It is assumed that in the larger plants, there will be such supervision available under ordinary working conditions that occurrences of this kind will be avoided ; but a simple device for preventing such abuse of the cells in smaller plants, where such supervision is not always convenient, has been devised. It is called an overload and overdischarge switch, and its operation is based on the fact that when a series of cells is overdischarged their potential falls below a minimum value, and that when they are worked above their normal rate the current exceeds a maximum value. The apparatus consists essentially of a pressure magnet connected to the terminals of the battery, and of a current magnet in series with the battery. When the potential of the battery falls below a minimum value, the armature of the potential magnet is released and throws an artificial resistance into the battery circuit, and thus reduces the current ; and similarly, when the current exceeds a maximum value, the armature of the current magnet is attracted and performs a similar function. With the object of reducing the cost of the regulating apparatus whenever both the combined overload and overdischarge switch and the current equaliser are to be used with the same series of cells, the switch portion of the equaliser may be mounted on the resistance frame, and thus a single resistance coil be made to do service for both instruments.

In applying accumulators to plants operated on the three-wire system, a simple extension of the method already described is adopted, except in the case of small stations requiring only one series of accumulators, and where the working circuits can be multiplied during the light load, so that the ordinary method will

Digitized by Google

suffice. In larger plants the batteries are installed in pairs, each series having the same apparatus as before; and as this has already been fully explained, it will only be necessary to add that in adapting two series of cells to the three-wire system, the two batteries are connected in series in the same manner that the dynamos are connected. The general plan of this arrangement is shown in Fig. 3, from which unimportant details have been omitted. At the top of this diagram the three horizontal lines M (+), M (±), and M (−) represent the omnibus wires in the dynamo room, from which the feeders, L, are led. The three vertical lines O (+), O (±), and O (−), are extensions to the omnibus wires to which the dynamos are directly connected in the usual manner when the levers of the switches S_1 are on their upper contacts. The batteries are also connected with the omnibus wires in a similar way, so that when the switches S_2 are closed on their lower contacts the batteries will also discharge into the lamp circuits in parallel with the dynamos. Now if the switches S_1 are turned to their lower contacts, and the switches S_2 to their upper contacts, the current from the dynamos will divide at the switches S_1, part going into the lamp circuits, and part through the batteries, which thus receive a charge. As in the multiple arc system, the potential of the dynamos being assumed to be raised above the normal to meet the requirements of the batteries in order to suitably reduce the pressure on the lamp circuits, it is only necessary to adjust the resistance of the pressure equaliser P E. In central stations, where the feeders are already provided with pressure equalisers, the connections are still more simple, for the batteries are merely connected to the omnibus wires, while all other connections of the ordinary three-wire station are unchanged. In such cases the increased pressure at which the dynamos are operated during the time the batteries are charging is

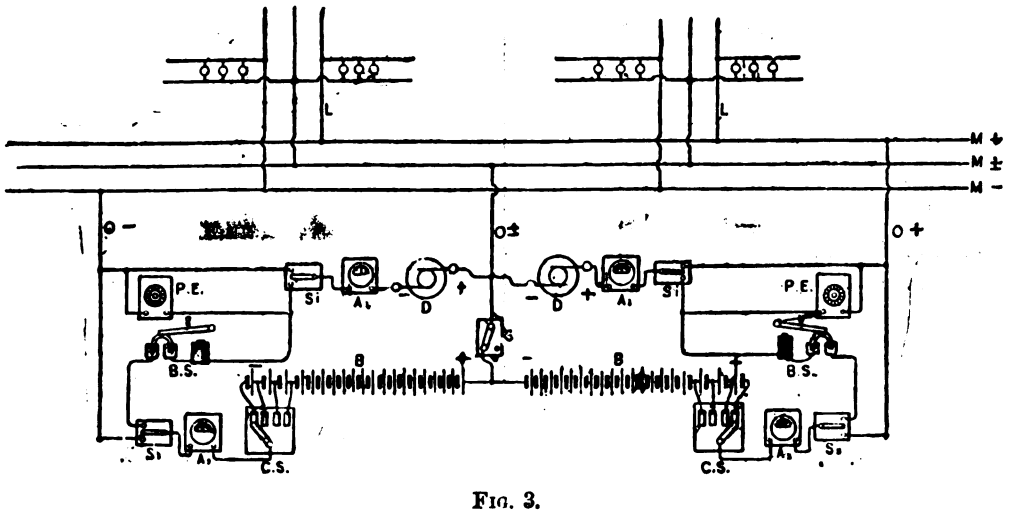


FIG. 3.

reduced at the lamps to the proper point by the usual adjustment of the feeder or pressure equalisers. During the charging period all regulation of the accumulators may be dispensed with by opening the switch S_1, when both batteries will be connected in a single series to the full pressure of both dynamos. In addition to the apparatus shown in the diagram each series of cells is provided with a double plug switch and sockets suitably disposed, by means of which the relative positions of the batteries on the two sides of the system may be changed by simply transposing the plugs from one socket to the other. The object of this arrangement is to provide means for compensating for the unequal discharge of the batteries when the two sides of the lamp system are unbalanced; and the transposition is never made oftener than once each day. In all other respects the manipulation of accumulators when applied to three-wire systems is practically the same as when they are operated on the multiple arc plan. To increase the accumulator capacity of three-wire stations, double batteries are added in parallel to the first set, just as additional dynamos would be.

Regulating cells in each series often become charged sooner than the remainder of the cells, and require to be removed from the circuit before the others. This operation, of course, calls for some labour; and, little as it is, it would still be desirable to have the number of cells in a series remain fixed both during charge and discharge. By the use of what are called counter electromotive force cells, this result may be effected, and at the same time the pressure equaliser be dispensed with. These very simple cells are made, like an ordinary Planté accumulator, of plain sheets of an inoxidisable lead alloy and without active material. When a current is passed through them they act as gas voltameters, and while they instantly oppose a counter electromotive force of about two volts, they are incapable of producing a current of any appreciable amount of duration on account of their inoxidisable property. The use of counter electromotive force cells in place of equalisers is advantageous in several ways, for not only may their internal resistance be made so small as to be practically negligible, but their counter electromotive force is as effectual in reducing excessive pressure as a dead wire resistance, while possessing the unequalled advantage that the fall in potential of the current passing through them is unaffected by any variation in the strength of such current. It is to be noted that by means of the above method, the number of cells in the battery proper is fixed and unalterable during both the charge and discharge, and that whenever the dynamo is supplying current to the lamps, its surplus current is always available for charging the battery; moreover, only one adjustment of the counter E.M.F. regulating cells opposed to the lamp current will be required. It is obvious that counter E.M.F. cells may be substituted with equal effectiveness for the equalisers and regulating cells employed in all of the previously-described systems, and it seems unnecessary to go into any further particulars in order to illustrate the practicability of such systems when properly installed and operated.

We have now to consider another branch of the electric lighting business, in which accumulators also claim a share of attention, viz., the supplying of current to lamps located at a considerable distance from the source of power. The first method to be considered is known as the half-direct plan, in which one or more series of cells are installed in any number of sub-stations conveniently located near centres of lamp consumption. The charging station may be situated wherever economy dictates, without any special reference to the location of the batteries, for although the expense of the charging wire and the cost of the energy wasted in it cannot be neglected, both these factors must be offset by the saving effected from locating the power station in the most desirable situation. This half-direct system is so called because during the period of maximum load half the current is supplied by the charging dynamo, and half by the batteries. At other times the dynamo may be simultaneously charging the batteries and supplying lamps, or the battery alone may be in operation. Each sub-battery station is, in fact, a small central station by itself, and it may contain one or several series of cells, the number, of course, depending upon the amount of lighting to be done in its vicinity. A common charging main, like an arc light circuit, passes through each sub-station, and each battery may be inserted in the main or withdrawn from it at will, exactly as arc lamps are cut in and out of circuit. The charging dynamo is usually of high voltage and of moderate current capacity. Machines of 500 volts and 15 amperes to 1,200 volts and 40 amperes may be employed in small stations, while in larger ones the latter machines and their circuits may be multiplied. For charging purposes shunt-wound dynamos are preferable on account of their non-reversibility, but even series and compound-wound machines may be used if suitable precautions are taken. The arrangement of the accumulators and regulating apparatus in each sub-station on the half-direct system is essentially the same as the method adopted in the last described multiple arc system. The switch which is employed to throw the batteries into and out of the charging circuit is of the snap action type, and is sometimes called a consumer's switch. It maintains the integrity of the charging circuit when the batteries are removed from it, and is provided with a spark coil which prevents the opening of the charging line and the consequent formation of the injurious arc which results on the interruption of high potential circuits. By applying the polarised magnet principle

Digitized by Google

to this switch it can be made to operate automatically from the central station through a momentary reversal of the charging current, a principle which has already been applied.

While the method just described of locating the batteries in sub-stations near the lamps to be supplied reduces the resistance of the supply wires to such an extent that the variation of potential with changes in current strength is unimportant compared with what it would be were all the lamps operated from one central point, under ordinary conditions; still a similar variation does occur from a different cause. We have already seen that the potential of a battery is higher while it is being charged than at other times, and that the greater the charging current the higher the potential of the battery becomes. It is evident that if charging commences when only a very few lamps are burning in a given battery only a small part of the charging current will be required by the lamps, while the greater part will pass through the battery. This will raise the potential of the battery considerably, and as the lamp mains are permanently connected to its terminals, the lamps will receive an excessive pressure. As the number of lamps increases, however, more of the charging current will pass to them and less through the battery, the potential of which thus becomes gradually reduced until it reaches a minimum, when the number of lamps burning becomes so great that the whole output from both the dynamo and battery is required to maintain them. The variation is in the opposite direction, of course, when the lights are diminishing in number. It is evident from the preceding facts that during the period when the charging dynamo is running and the lamp loads are varying some regulation of the pressure at the lamps mains at each sub-station is required. This regulation is automatically effected by means of the apparatus shown in Fig. 4, in which a solenoid magnet, A R, and a polarised magnet, P M, are inserted in the battery circuit. The operation of the apparatus in this sub-station will be as follows:—Assuming the charging dynamo to be delivering

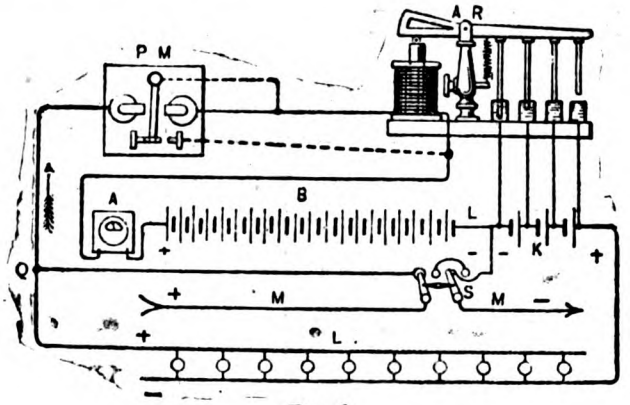


FIG. 4.

a current through the charging main, M, and that the consumer's switch is in the position shown in the diagram, the charging current will pass from M (+) to the point Q, where it will divide, part going through the lamps and the opposed counter electromotive force cells, K, to the point L, and thence to the line again, the remaining part of the current passing from point Q through the magnets, P M and A R, and out through the battery to point L and line. When the current is flowing in the direction of the arrow, as in the case just cited, the armature of the polarised magnet is moved to its left-hand contact, as shown, and the plunger of the solenoid magnet is more or less drawn down, according to the strength of the current. This action of the solenoid magnet causes one or more counter electromotive force cells to be inserted in the lamp circuit in such a way as to oppose their electromotive force to that of the charging current, while the full pressure of this current is available at the battery terminals. If now the number of lamps is increased to such an extent that not only all of the charging current passes through them, but also that more or less current from the battery joins in parallel with it, then the current from the battery will traverse the polarised magnet in the opposite direction from that previously taken by the charging current, and its armature will be moved against its right-hand contact, thus short-circuiting the solenoid magnet and the counter electromotive force cells, as indicated by the broken line. For, as the sketch shows, the lever of the solenoid magnet is so balanced that when no current is traversing the magnet, its metallic contact rods all dip into their respective mercury cups, and so shunt around the counter electromotive force cells with which the latter are in electrical connection. When the lamp load becomes reduced, and the charging current is discontinued either by the stoppage of the dynamo or by its being shunted post that particular battery by a movement of the switches to the right, the battery alone works into the lamp circuit, and the counter electromotive force cells are short-circuited.

While the automatic regulator just described, when applied to the half-direct system, maintains the pressure at the lamps sufficiently uniform for practical purposes, whether the charging dynamo is operating or not, and although the proximity of the battery to the lamps it supplies prevents undue variation of potential when the load changes, yet a perfectly automatic method of maintaining a constant potential at the lamp circuits, even where the resistance of the leads is great, would be generally useful. Such a method is illustrated in Fig. 5, in which the battery, counter electromotive force cells, lamps and charging circuits, occupy the same relative positions as before. The solenoid magnet of the regulator is no longer in series with the battery, however, and is, in fact, entirely disconnected from it, while the polarised magnet is replaced by a second solenoid magnet, P M, wound to high resistance. The armature lever of this second solenoid is so mounted that when its core is attracted or released this lever moves over a series of contact strips which are insulated from each other. Connected with these contact strips are coils of wire of suitable resistance, the whole constituting a simple rheostat, more or less of the wire of which is included in a local circuit, according to the position of the lever, which acts as a movable contact. The solenoid magnet of the regulator, A R, and one or two cells of accumulators are also included in the local circuit referred to, the strength of the current flowing in this circuit depending upon the amount of resistance inserted by the movement of the lever of the pressure magnet, P M. The latter magnet is connected directly with the lamp mains at a point of average potential, and as this potential rises and falls, the current flowing through this magnet varies correspondingly, causing a similar variation in the current in the local circuit. Thus an increase of pressure at the lamps indirectly causes the armature of the regulating magnet, A R, to be attracted, and this in turn opposes one or more counter electromotive force cells in the lamp circuit until the pressure again becomes normal. If the pressure at the

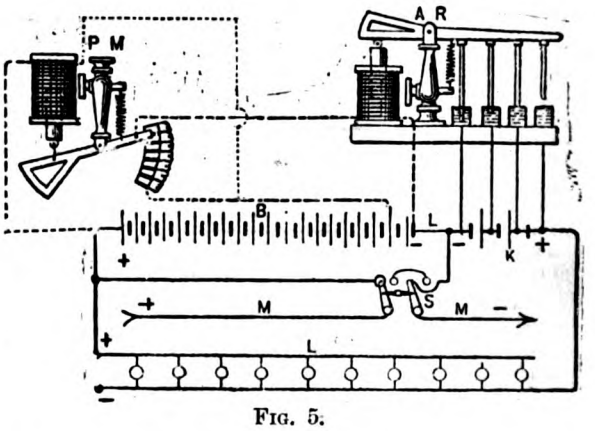


FIG. 5.

lamps falls below normal, the regulator acts in the reverse way, cutting out the counter electromotive force cells until the normal pressure is again restored. If in connection with this method the polarised consumer's switch, previously mentioned, is substituted at S, the operation of such a sub-station will be entirely automatic.

It is proper to mention that the pressure magnet must be very sensitive, and requires a delicate adjustment, besides being somewhat costly on account of the excellence of the workmanship required. Although I have only seen the instrument used in an experimental way, its practical application to similar purposes has given satisfactory results. Under certain circumstances—as, for example, when a lighting station is worked to its full capacity at night, but during the day time has ample surplus power, the all-accumulator system may often be applied to increase the capacity of such a station with satisfactory results. In such cases the sub-stations of accumulators are located at distant points in the usual way, the cells being charged during the day and discharged on the lamp circuits at night while the power plant is doing its regular work. The arrangement of the accumulators and regulating apparatus in the sub-stations of the all-accumulator system is practically the same as when the half-direct system is employed, except that a single transfer switch, which transfers the battery from the lamp circuit to the charging circuit, and *vice versâ*, is used instead of the consumer's switch.

There are, of course, numerous other ways of utilising accumulators in central station supply systems—such, for example, as the double battery method now operated in England by the Electrical Power Storage Company, in which the dynamos are kept running for 24 hours daily, duplicate sets of accumulators being alternately inserted in the charging and supply circuits at uniform intervals of time by an automatic mechanical device. But I have limited this Paper to a description of some of the simpler methods of accumu-

Digitized by Google

LIST OF ELECTRICAL ACCUMULATOR COMPANY'S STANDARD CELLS.

(*Approximate Data.*)

Type of cells.	Charging current.	Working rate and capacity. Amperes.				External dimensions of jars. Inches.						Weight of acid. lbs.		Weight complete cell. lbs.		Height over all, including connections.
	Normal.	Normal.		Maximum.		Glass.			Rubber.							
	Ampere.	Rate.	Ampere hours.	Rate.	Ampere hours.	Length.	Width.	Height.	Length.	Width.	Height.	Glass.	Rubber.	Glass.	Rubber.	Inches.
15 L	15 to 30	30	300	40	250	$10\frac{3}{4}$	$12\frac{1}{4}$	$13\frac{1}{4}$	...	...	...	50	...	130	...	$15\frac{1}{2}$
25 M	10 to 25	25	150	30	110	$10\frac{1}{2}$	$8\frac{1}{2}$	$9\frac{7}{8}$	$6\frac{1}{4}$	$7\frac{1}{8}$	$9\frac{7}{16}$	16	11	50	40	$11\frac{1}{2}$
15 M	5 to 15	15	100	20	70	$7\frac{1}{4}$	$8\frac{1}{2}$	$9\frac{7}{8}$	$4\frac{5}{8}$	$7\frac{1}{8}$	$9\frac{7}{16}$	11	7	35	25	$11\frac{1}{2}$
7 M	2 to 6	6	40	8	25	$4\frac{7}{1}$	$8\frac{1}{2}$	$9\frac{7}{8}$	$2\frac{5}{8}$	$7\frac{1}{8}$	$9\frac{7}{16}$	6	$3\frac{1}{2}$	20	13	$11\frac{1}{2}$
5 S	1 to 2	2	8	3	6	...	...	...	$1\frac{7}{8}$	$3\frac{3}{8}$	$6_{\frac{1}{16}}$	...	$\frac{1}{2}$	...	$2\frac{7}{8}$	7

Electromotive force of each cell is about 2 volts.

later regulation which may be readily adapted to ordinary lighting plants, and, in concluding, can only hope that I have succeeded, to some extent at least, in showing that when so applied in an intelligent manner accumulators do occupy a useful place in the industry of electric lighting.

Through the courtesy of the Electrical Accumulator Company I am enabled to present to the Institute this evening a list of a new line of standard accumulators recently brought out by that company.

THE PHYSICAL SOCIETY.

At the meeting of the Society, held on the 15th inst., Mr. J. Enright resumed the performance of some experiments begun at the last meeting, exemplifying

"Electrification due to the Contact of Gases with Liquids."

The author has been making experiments for some time past on the electrical phenomena accompanying chemical action. He finds that when a vessel in which chemical action is going on is insulated and put in connection with a delicate electrometer, electrification can generally be observed when a gas is given off, but not otherwise. The sign of the charge given to the vessel depends, as would be expected, on the liquid employed and on the gas given off, and the author adopts the natural explanation that the effect is due to contact between the liquid and the gas.

The first experiment exhibited to the Society consisted in dissolving zinc in hydrochloric acid in a vessel in connection with a quadrant electrometer, and the author stated that as the proportion of chloride of zinc in the solution gradually increased, the deflection of the electrometer gradually diminished to zero, and ultimately changed its sign.

Hydrogen gas, generated in the same manner, was then allowed to escape into a metallic vessel, suspended with its mouth downwards over the escaping gas, and connected with the electrometer, and it was found that the charge given to the suspended vessel by the escaping hydrogen was opposite in sign to that of the generating vessel in the preceding experiment.

The author stated that when the hydrogen was allowed to escape into a glass vessel the electrification given to the vessel was of the same sign as that of the generator, from which he concluded that the arrangement acted like a condenser. This idea he confirmed in a very ingenious manner by dissolving soap in the acid, so that a mass of small bubbles was formed by the gas, and then striking this mass with a proof plane, which became charged oppositely to the generator. The hydrogen could not be made to part with its charge even by driving it through water, but it became neutral if allowed to stand for four or five hours.

When hydrogen gas, which had lost its charge by standing a sufficient length of time, was allowed to bubble through water, no electrification was produced, and the author attributed this to the surface of contact between the gas and the liquid being insufficient to produce a sensible electrification.

DISCUSSION.

In the discussion which followed,

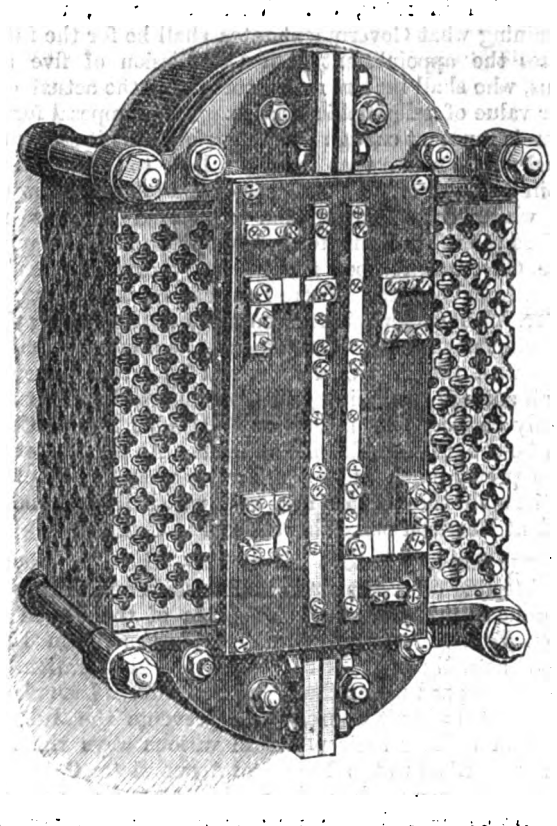
Prof. RÜCKER inquired if the author had observed whether a change took place in the sign of the electrification if the zinc were introduced in the first place into a solution of zinc chloride, and hydrochloric acid subsequently added.

Dr. BURTON suggested that the hydrogen should be shaken up with the liquid in a bottle, which might possibly produce sufficiently intimate contact to give an appreciable result.

Mr. ENRIGHT, in reply to Prof. Rücker's question, stated that he had tried the effect of beginning with zinc chloride in solution, and that the deflection could be reversed again and again by adding acid whenever the amount of the chloride became so great as to produce a deflection opposite to that with the pure acid.

THE SIEMENS AND HALSKE TRANSFORMER.

At the recent Berlin Exhibition Messrs. Siemens and Halske had an interesting historical collection of the various types of dynamos built by the firm during the last twenty years. Among others they showed a flat ring armature machine of 1869, their first alternator of 1875, and the first compound, built in January; this latter was at work in Berlin from 1883 till 1887. They also showed their newest inside magnet machine, which was referred to in *The Electrician* of November 1st, p. 647. In the annexed figure is shown the exterior of the Siemens' transformer, of which two were exhibited, one 5 and one 10-unit. The construction is not very lucidly described; but we gather that an equivalent of the Kent shield is used, consisting of a thin tertiary coil between the primary and secondary, one end of the tertiary being earthed and the other open. The *Elektrotechnische Zeitschrift*, from which we extract these details, merely remarks concerning the terminal board of the transformer that it is made of insulating and fire-proof material, carries four lead fuses, and the terminals of the *primary and secondary* coils.



BOOKS, &c., RECEIVED.

"Treatise on Statics." Vol. II. By Prof. Minchin. (Clarendon Press.)

"The Thomson-Houston Electric Railway System." (Boston, Mass.)

"Die Elektrische Beleuchtung." By Dr. Alfred von Urbanitzky. Second Edition. (Vienna: Hartleben.)

Digitized by Google

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *November* 9, 1889.

The Postmaster-General and the Western Union Company.—It will be remembered that a few weeks ago Postmaster-General Wanamaker fixed a tariff for the ensuing year for Government telegraph messages, at the extremely low rate of one mill (or one-twentieth of a penny) per word. This rate was so evidently below the actual cost of the service, that not only did the Western Union protest strongly, but its complaints were echoed by a large number of newspapers, which, as a general thing, are very much averse to saying anything in support of monopolistic interests. For a short time Mr. Wanamaker stood his ground, and attempted to justify his action, but he has now been convinced of his error and has revised his scale of payments. He now fixes the rates at an average of 10 cents a message of not more than 10 words, exclusive of date, place of dispatch, address and signature, for all distances not exceeding 400 miles. For night messages, the corresponding rate is 15 cents for 20 words. The whole scale for longer messages and greater distances is adjusted to this basis. In writing to Dr. Green on the subject, Mr. Wanamaker says that he does not admit that the privileges accorded to telegraph companies by Congress are of no value, but that, on the contrary, he is convinced that the Government is entitled to very special consideration in rates, &c. With the view, therefore, of determining what Government rates shall be for the future, he proposes the appointment of a Commission of five suitable persons, who shall inquire and report as to the actual cost and proper value of telegraphic service. This proposal for a Commission is innocent enough on the surface, but it seems to have escaped public notice that it might lead to important results. It is, in fact, one of the provisions of the telegraph law of 1866 that, whenever a Commission appointed in this manner appraises the value of any telegraphic plant, it can be purchased by the Government upon the necessary authority and appropriation from Congress. There has been not a little expectation that Mr. Wanamaker might recommend to the coming Congress the establishment of a Government telegraph system in connection with the Post Office. It will be seen at once that, if he shall succeed in obtaining his Commission, he might unostentatiously be placed in possession of specific information upon which he could base a definite scheme. At present, of course, we are pretty much in the dark as to what Mr. Wanamaker's intentions in the matter are, and we shall not know until President Harrison makes his address to Congress.

Storage Battery Patent Litigation.—There has been a very general feeling of regret among electricians and on the part of the public in this city at the stoppage of the Julien storage cars on Fourth Avenue, where, by this time, from 15 to 20 cars had actually been got ready and put in operation. These cars have stopped under the decision of Judge Lacombe, in the United States Circuit Court, which prevents the Julien Company from making their plates in various ways the right to which is ascribed to the Electrical Accumulator Company, and which leaves open to them the method whereby a perfectly dry powder is compacted upon the grid by hydraulic pressure and no fluid is added until the plate goes into use in the battery. The Julien people, it would seem, have been trying to accommodate the Court so as to make their plates in such a manner as to satisfy the judge that there was no infringement, and now that they have ascertained just what the judge deems right they will go ahead as briskly as at first, and will produce as many of the dry-powder plates as may be required. The company make the statement that these absolutely dry plates are far better than they had anticipated, and that they will answer their purpose better than any that they have employed heretofore. This dry-powder method is claimed as covered by one of the early patents of Mr. B. Brush, but this does not have any material bearing upon the case, it would appear, as it is rumoured that an alliance between the Brush and Julien storage battery interests exists. In fact, it is asserted that the Courts will probably sustain one or more of Mr. Brush's patents in which is granted broadly the mechanical application of the active material in any form to a separate plate, whether that active material be a paint, paste, plaster, powder, or anything else beginning with a "p." Should that be the case, Mr. Brush, or his representatives, would control the situation; but for the present the Electrical Accumulator Company are very well satisfied with the aspect of things, and propose to enforce as thoroughly as possible their rights with regard to manufacturing plates in which the active material takes the form of a paint, paste, or cement.

Flake Mica as an Insulator for Electrical Conduits.—The frenzied discussion in the public prints as to the safety or danger of overhead wires has naturally diminished somewhat, it being impossible that the pitch could be maintained. Of course, all this discussion has given a tremendous impetus to the production and exploitation of high-insulation wires, and it has also greatly stimulated ingenuity in regard to subways and conduits. One interesting new scheme which has been put forward in Boston is to run the wires through ducts which have been filled up with flaked mica. In such ducts the wires can be easily pulled through, as the material is yielding. The pipes would be made of indurated fibre, and the insulation of the wires would consist of only one dry-cotton braiding. It is claimed that when the wire is in the conduit and thoroughly embedded in the flaked mica, no moisture can possibly attack the insulation, and that as long as the cotton can be kept dry the insulation will, of course, be maintained perfect. Various objections to this scheme suggest themselves, one of which is the difficulty of obtaining pure mica in sufficiently large quantities; but there seems a likelihood that the scheme will be tried, and then we shall know more about it.

The Pittsburgh Reduction Company.—A few weeks ago reference was made in this letter to the method of the Pittsburgh Reduction Company for the production of aluminum. This concern has now made a most surprising cut in the prices of aluminum in the form of ingots. It announces that it will sell 1,000lb. lots at $2 per lb., 500lb. lots at $2.25 per lb., 100lb. lots at $2.50 per lb., 50lb. lots at $3 per lb., and small lots at $4 per lb. Up to the present time the lowest quotations on aluminum have reached from $4 to $6 per lb., but, as will be seen, the price is now quoted as low as $2. Such a reduction as this will undoubtedly do much to stimulate the use of the metal, with corresponding benefit to the Company. It may be that the Company has resorted to this policy as a means of advertising itself, for undoubtedly the announcement will be universally noted, but, on the other hand, there is no good reason to doubt its desire and ability to fill as many large orders as it can possibly get at these very low prices.

Electricity and Mining.—Speaking of aluminum reminds me that Mr. George Westinghouse, jun., who has so many irons in the fire, and who certainly has most wonderful success in keeping them all red hot, has just added to the list of his enterprises. This new departure is the purchase of some valuable copper mines in Arizona, and Mr. Westinghouse has formed a company to operate the property. The production will be used at Pittsburgh in the operations of the Westinghouse Electric Company, which uses several millions of pounds of copper every year, and which by having its own mines stands to save a great deal of money. The mines will give employment to about 300 men, and the work will begin almost immediately. It is somewhat a matter of surprise that other companies have not already undertaken similar operations, so as to save money for themselves in this way. In fact the connection between electricity and mining promises to become very much closer than it has been hitherto. It is no secret that many of the companies now engaged in the production of electric motors and electric power apparatus in general are turning their energies in the direction of mining work, and while not neglecting the stationary motor field and the street-railway business, are reaching out for these new and inviting fields in the mining industries of the country. It may even be said that the interest in the subject is even greater among the mining men than it is among the electricians, for the mining men perceive how, by the utilisation of distant water-power, they will be able to derive rich returns from mines where the cost of production has been so enormous as to offset the value of even the highest grade ore. During

Digitized by Google

the present week I heard of several very interesting installations actually started or about to be equipped, and there will soon be some important news in connection with this department.

The New Western Union Cables.—Just at the present moment the cable-laying steamer "Faraday" is off our shores, and is preparing to lay the first shore end of the new Western Union cables between Coney Island and Canso, N.S. Two cables are to be laid, and it is proposed to render the service between New York and Great Britain free of the interruption due to the winter storms which have so often broken down the land lines on this side. It is interesting to note that, although there has been not a little talk of late in regard to the desirability of pushing submarine cable-laying enterprises, the Western Union Company still goes abroad for its cables and for the people to lay them.

CORRESPONDENCE.

THE CITY AND GUILDS TECHNICAL EDUCATION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: While thoroughly agreeing with the opinions expressed in the able leader in your last week's issue on "The City and Guilds Technical Education," there are two points I should like to refer to in order to avoid misconception. It is stated in reference to the work of the Central Institution—"The value of work of this kind is not to be measured merely by the numbers who are trained in this manner; and, indeed, it would not be advisable to turn out men of this kind in any very large numbers, for the simple reason that it would be impossible to find places for them all." The reason I think, however, why it would be impossible to find places for a large number of students if turned out by the Central Institution would not arise from want of openings, but because it would be impossible to give large numbers the individual attention which the present students receive in the workshops, laboratories, and in drawing offices; and, therefore, it would be impossible to turn out large numbers with the thorough training that the present students now obtain.

In speaking of the lowness of the fees at the Central Institution it is stated in your leader:—"We, on the other hand, are inclined to agree with the majority of those who send their sons there, and who are almost unanimous in their wonder at the extreme lowness of the fees compared with those which they would have to pay for from three to five years if their sons were apprenticed to an engineering firm; and students after leaving the Institution, except in cases of exceptional ability, usually find that they have to pay more for their final year, spent in an engineer's workshop, than for their three years at this Institution." From this it might fairly be concluded that it was the usual thing for students who had passed through the Central Institution to pay a premium when entering a manufactory, but, as far as I am aware, of all the students who, on completing the course at the Central Institution, have gained the diploma and "Associateship of the Institute," only one has ever paid a premium on entering a manufactory, while many of them have commenced receiving a small salary of a couple of pounds a week directly they left this college.—Yours, &c., W. E. AYRTON.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Your note in last week's issue practically demolishes the elaborate structure raised by "Observer" on wrong bases, and therefore it is not necessary to reply to the arguments and deductions which he has "excogitated from his inner consciousness," as the German philosopher did the camel. "Preponderance" forsooth, when our protest is only raised against annihilation! It does not require a large black board and a quantity of chalk to demonstrate the vast difference between preponderance and *extinction*, and I am confident that the modest desires of the telegraph fraternity will be quite satisfied with two or three representatives on the Council. If, in addition, the mathematicians will remember that we are an indispensable factor in the progress of the world, and that our profession has altered the relations of all civilised nations, and is by far the most important application of electrical science, the need of a new Society will pass away.

If the present Institution were fully representative of all branches of the science, there would be no room for another Society. But what are we to do with such Councils as we have had for the last three years, and how long are we to remain members of a Society which has ceased to interest or instruct us? The blame of the threatened schism must rest with the Councils which have seen one after another of the most prominent telegraph members sending in their resignations, and which have confined themselves to writing conventional letters of regret without considering whether or not their own policy was to blame. Their very confession of the extraordinary oversight of Land and Submarine Telegraphy, at the recent dinner, is evidence that our profession had passed completely out of their thoughts, and their complaint that Papers on Telegraph matters have almost ceased is a further proof that the Institution has ceased to claim the attention or satisfy the needs of Telegraph men. Strongly as I would deprecate the formation of a new Society—at least until we see whether our just claims cannot be met—it is only right to add that the new venture has been taken up with alacrity in high circles, and several excellent and novel features suggested, which would make it something much more than a mere scientific Society. I would strongly urge, however, that these new features should be kept for the strengthening and broadening of the old Society—that is, if we can make the Council representative of the whole science of Electricity.

It must be remembered that the complaints against the Council are not confined to Telegraphy, for other branches are at least equally ignored. It is true there are no Postal Telegraph successors to Messrs. Preece and Graves, but it is equally true that there never was a Telephone representative on the Council, nor is there any Railway Telegraph Engineer to succeed Mr. Spagnoletti when he shall have retired to a well-earned repose. Where are the "cable" men to fill the places of Willoughby Smith, Weaver, Andrews, and Ansell? "Instead of which" there are no less than *thirteen Professors*, three or four Military, and a number of Electric Light men. "This will never do," as Jeffrey said of Keats' "Endymion." Mathematics and arc lamps form only a portion of the resources of civilisation, and if the Council were composed, say, of two representatives of each branch—Postal Telegraphy, Ocean Telegraphy, Railway Telegraphy, Military Telegraphy, Electric Light, Telephony, and manufacturers, we should probably have a Council which would neglect no interests and blunder into fewer apologies through lack of catholicity.—Yours, &c.,

TELEGRAPHY.

ELECTRICAL INSPECTORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Now that the question of Board of Trade regulations and of the Model Provisional Order has been settled, so that *bona fide* companies can, on satisfying the powers that be of their financial capabilities, carry out their schemes, it is most important that everyone should have a clear and correct idea of the protection afforded to undertakers as well as to the public, who, as a body, cannot protect themselves.

On looking through your valuable paper there will be found many utterances of opinion on subjects affecting the legal phase of central station lighting. On page 428 of August 10th of last year, in an editorial article dealing with the electrical inspector question, you say that "either the undertakers or the consumers are at liberty to require the inspector to test the accuracy of any current or energy meter." Now this is not so as regards a current meter, there being no regulation in the Acts or Orders that requires or takes notice of the current rate, with the exception of the clause mentioning the "maximum supply demanded by the consumers." The points raised are those only of pressure and of quantity of electricity. Probably the word "current" ought to read "quantity."

Digitized by Google

I might also point out that nothing is said in the Orders about the testing of quantity meters until complained of by either party to the transaction of selling and buying electrical energy beyond the word "correct" before the word meter. There is no compulsory testing on the part of the electrical inspector before sealing, provided he is convinced the instrument is a "correct meter."

You then quoted the words "competent and impartial," as applied in the Model Order to the individual above mentioned: it may not be amiss to mention that only one adjective is *now* applied, and certainly with greater correctness. You remarked in this connection that it would be necessary to appoint an electrical inspector-in-chief. This post in reality, though perhaps not in name, is now held by the Electrical Adviser to the Board of Trade, a gentleman who certainly comes up to your standard, being one who is "not merely qualified by technical knowledge and ability, but also by actual experience of electrical engineering on a commercial scale."—Yours, &c., CHARLES H. YEAMAN.

Liverpool, November 14th.

A LONG-LIVED INCANDESCENT LAMP.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It may interest you to know that an incandescent lamp (Woodhouse and Rawson), which was put up on September 2nd, 1888, and which has been burning continuously ever since, has now burnt out, after the phenomenal life of 10,608 hours.

As this was a 98-volt lamp, and was on the charging leads of a 50-cell battery, you will see that during a considerable part of its life it was burning a good deal above its nominal candle-power.—Yours, &c., ORLO. V. THOMAS,

Taunton, November 20th, 1889. Electrician-in-Charge.

LEGAL INTELLIGENCE.

COURT OF APPEAL.

The Queen v. Redman.

This was an appeal heard before the Master of the Rolls, Lord Justice Lindley, and Lord Justice Lopes, on Thursday last week, from the decision of a Divisional Court, reported in *The Electrician* of November 1st. The London Electric Supply Company had erected at Deptford very large buildings, the eastern wall of which adjoined the premises of the General Steam Navigation Company. The buildings were completed in March, 1888, and in November, 1888, the General Steam Navigation Company discovered by digging that the wall had not proper footing as required by section 12 of the Metropolitan Building Act, 1855. Mr. Redman, the district surveyor for North-East Deptford, having refused to put in force the provisions of the Act, and to compel the London Electric Supply Company to comply with it, the General Steam Navigation Company obtained a mandamus to Mr. Redman to compel him to enforce the Act. From this Mr. Redman appealed.

Mr. FINLAY, Q.C., with Mr. BREMNER, for the appellant, contended that it was not a case for a mandamus. He read the affidavits of a large number of surveyors to the effect that the building was perfectly safe and substantial. The district surveyor had a discretion under the Act, and if he considered, as he did, that the building was perfectly safe without the footing required by the Act he need not insist upon it. It was impossible now to fulfil the provisions of the Act without pulling down the whole building and recommencing it. No magistrate would direct that to be done in the case of a building which was perfectly safe.

The ATTORNEY-GENERAL and Mr. C. A CRIPPS, for the General Steam Navigation Company, said that the case was one of great importance. The General Steam Navigation Company employed some 400 workmen on these premises, whose safety was endangered by this wall. The statute left no discretion in the matter, but required certain footings to every wall. It had been in force many years, and the surveyor had no discretion to vary the minimum given by the statute for safety. The question of safety could not be determined in these proceedings. When the magistrates came to consider the question of penalties, that question might arise, but it could not be raised now.

The MASTER of the ROLLS said that the Court would not give judgment for a fortnight, and meanwhile the parties would do well to come to some arrangement.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

October 25, 1889.

16,839. J. PERRY. London. An electric supply meter.

16,847. H. J. ALLISON. London. Improved system of electric generation and apparatus (J. I. Conklin and W. H. Rushforth, United States).

16,879. C. P. ELIESON. London. Improvements in and connected with electricity meters.

16,887. F. H. W. HIGGINS. London. Means for ascertaining the state of the vacuum in incandescent electric lamps.

16,890. E. FRANKLAND, A. H. HOUGH, and D. G. FITZGERALD. London. Improvements in elements for secondary batteries.

October 26, 1889.

16,917. J. FARQUHARSON and F. V. ANDERSEN. London. Improved winding of armatures of dynamos.

16,947. A. DE MÉRITENS. London. Improvements in treating and rectifying or ageing alcohol or alcoholic liquors or the like by electricity.

October 28, 1889.

16,978. J. M. M. MUNRO. Glasgow. Improved arrangement of conductors for electric series traction.

17,004. H. I. HARRIS. London. Improvements in electric terminals and switches.

October 29, 1889.

17,045. F. MORLEY. Cambridge. The insulation of electric wires or cables.

17,060. T. PACKER. Wolverhampton. Improvements in electrical furnaces and in their manipulation.

17,062. W. F. C. WARD. London. A miners' or safety lamp and battery.

17,075. P. HADEN. London. Applying electric current for heating rivets (H. H. Bales, East Indies).

17,115. F. X. BACHMANN. London. Improvements in electro-magnetic telegraph apparatus. (Dated October 30.)

PATENT
SILICIUM BRONZE AND SILICIUM COPPER WIRE.
The best for overhead Telephone and Telegraph Lines,
AND ALL ELECTRICAL PURPOSES.
Hard Drawn High Conductivity Copper Wire.
ROLLED AND DRAWN
PHOSPHOR BRONZE.
PHOSPHOR BRONZE
BEARINGS, BUSHES,
AND OTHER PARTS OF
ELECTRICAL MACHINERY.
SOLE PROPRIETORS of the British, Indian and Colonial Patents,
THE PHOSPHOR BRONZE COMPANY (Limited),
87, Sumner Street, Southwark, London, S.E.
WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

Digitized by Google

17,118. L. PAGET and C. J. KINTNER. London. Improvements in and relating to electrical transformers or converters.

17,124. W. P. THOMPSON. Liverpool. Improvements in interrupting devices for electric circuits applicable for protecting electrical apparatus connected in such circuits (The Westinghouse Electric Company, United States).

17,138. T. C. DE BOYÈRES, Sen. London. Electric or electro-magnetic elements or rings, applicable to collars, muzzles, and other articles for use with animals for the purpose of preventing rabies in such animals.

17,142. L. BOLLMANN. London. Improvements in electro-magnetic induction apparatus for transformers, generators, or motors.

October 30, 1889.

17,221. H. L. TODD, W. F. MELBOURNE, J. THOMPSON, and R. E. M. MOSTYN. London. Improvements in electric telephonic apparatus.

October 31, 1889.

17,252. F. M. A. LAURENT-CÉLY and I. A. TIMMIS. London. Improvements in electric secondary cells.

17,260. W. H. OAKLEY. London. Improvements in holders for incandescent electric lamps.

17,274. G. S. GRIMSTON. London. An electric switch (partly communicated by Frank Jacob, at present on the high seas).

17,276. G. DONOVAN and W. DONOVAN. London. An improved socket and adapter for electrical purposes.

COMPANIES' MEETINGS.

The Australasian Electric Light, Power, and Storage Company (Limited).

We have been supplied with the following report of proceedings at an extraordinary general meeting, held at the offices of the Company, on Tuesday, the 12th inst., under the presidency of Mr. B. H. Van Tromp:—

The SECRETARY having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, it will be within your recollection that when we met in July last you passed a resolution approving an agreement which we had then entered into with the Brush Company. I then told you I thought it highly probable that certain arrangements would have to be made which would render necessary an alteration in the terms of that agreement, and I fully prepared the shareholders for the possibility of our calling another meeting to make a statement as to the new arrangements so entered into. I may mention also that at that moment the Brush Company were in a condition of transition, acquiring not only powers to increase their capital and powers to extend their operations by amalgamation with a manufacturing company, but to actually change themselves into a new company, and, therefore, we were advised by our solicitor, Mr. Ince, that for that reason alone, if for no other, it would be advisable to make a change in the arrangement. I also mentioned to you that, in consequence of the distance that separated us from our field of operations in Australia, we were not quite certain as to the precise condition of some of our patents. There were other matters, too, in abeyance there, upon which it was necessary we should be more fully informed, and now, under the advice of our solicitor, the Board has decided upon the new modification. By the present arrangement we do not propose to hand over to the Brush Company the whole of the assets of this undertaking, but we agree to sell, and indeed have sold, subject to your approval, the patent rights and goodwill of the business in India and the Cape, Australia, and Australasia generally, and also the shares which this Company holds in the Melbourne Company. We retain the whole of the other assets, comprising the plant in England, India, and Australia, book debts and various matters, including the balance of the call in course of payment. Under this arrangement, therefore, the Brush Company, under the name of the Brush Electrical Engineering Company, give us for the patent rights and the other assets I have mentioned, £30,000 in their shares. These shares will be divided *pari passu* among the shareholders of this Company. I may mention that the shares of the Brush Company are at a premium of 5s. to 10s. per share, so you will, I trust, be placed almost immediately in possession of assets which can be immediately realised and sold, if you desire to sell . . . It is a condition of the agreement that we shall within a few months liquidate this Company. We have made an arrangement with our purchasers that they themselves will provide the expenses of the liquidation, including the stamp duties on the transfers, &c., so that there will be no reduction on that account from the £30,000 in shares which you are to have. In addition to that, we shall do the best we can when we go into liquidation, and the proceeds of the other assets we shall divide among the shareholders *pro rata* according to their holdings, so that we hope in addition to the shares which we shall hand over to you, to return you something in cash. . . . Mr. Ince informs us that we are now in a position to transfer our patents without encumbrance and without any difficulty whatever to the new company. I now beg to formally propose the following resolution:—

"*It is hereby resolved to adopt, ratify, and confirm the agreement, dated the 23rd day of October, 1889, and made between the Australasian Electric Light, Power and Storage Company (Limited) of the one part, and the Brush Electrical Engineering Company (Limited) of the other part; and the Directors are hereby authorised and requested to do all things that may be necessary for the purpose of giving effect to the said agreement, and carrying out the provisions thereof, either with or without modification.*"

Mr. TURNER seconded the motion.

The CHAIRMAN, in reply to questions from shareholders, stated the shares would be issued as fully paid, and would be divided in the proportion of two-fifths Preference and three-fifths ordinary, the former bearing a preferential dividend of 6 per cent. There would be no further liability of any kind or description attaching thereto, and the Board hoped shortly to be able to call a meeting to formally wind up. As to the unpaid calls, those who had not paid the final call would get nothing, so that it would be to the interest of all to pay up any calls that might be in arrears. There was a possibility of a slight reduction from the £30,000, owing to the possible extinction of one of the patents in Australia. He did not think this contingency at all likely to occur, but had the fullest belief that the shareholders would receive the whole of the £30,000.

The resolution was then put and carried unanimously.

A cordial vote of thanks to the Chairman and Directors for the very satisfactory way in which the negotiations had been conducted, proposed by A SHAREHOLDER and seconded by the Rev. W. J. STOBART, brought the proceedings to a termination.

The CHAIRMAN intimated to the meeting that the proposals of the Directors had met with opposition from only one shareholder with five shares.

CITY NOTES, &c.

BATAVA (LIMITED).—This Company was recently registered with a capital of £100,000 in £1 shares, and amongst the businesses which it is formed to undertake is that of tinsmiths, waterworks proprietors, electricians, electrical engineers, suppliers of electricity and of the electric light, and any other business incidental to or arising out of, or which can be conveniently carried on in connection with such businesses. There shall not be less than three nor more than eight directors.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended November 15th amounted to £5,204.

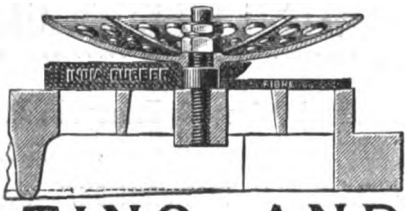
WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended November 15th, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,714.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The receipts of this Company for the half-month ended November 15th amounted to £2,841, as compared with £2,319 in the corresponding period last year, an increase of £522.

PERSONAL.—We understand that Mr. Gisbert Kapp has taken offices at 31, Parliament-street.

NEW VALVE

No Rubber, Percha, or Leather.



One-half the price of Rubber or Metal.

FOR CIRCULATING AND AIR PUMPS.

Unaffected by any Lubricating Oils. Does not Expand in diameter. Feed Water may be worked at any temperature Suitable for any shaped guards. Only one quality manufactured.

"12, John-street, Sunderland, 26th Sept'. 1385.

"DEAR SIRS,—In reply to your letter of the 25th inst., the Valves I got from you have done their work well, and ARE AN UNQUALIFIED SUCCESS. I will continue to get them from you as required.—Yours faithfully, JAMES WESTOLL."

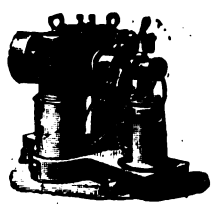
For further Testimony and Prices, apply to MOSSES & MITCHELL, 68-71, Chiswell Street, London.

Digitized by Google

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Wednesday, Nov. 20, 1889.	Rate per cent. Yielded.	Dividend Due.	Business done during Week Ending Nov. 20, 1889.	
					£ s. d.		Highest.	Lowest.
			TELEGRAPHS.					
£								
1,770,360	Stock	12/6	Anglo-American	50 51	5 7 10	Jan., Apr., July, Oct.	50½	50
2,614,820	Stock	25/0	Do. Preferred	85 86	6 7 11	,, ,,	86⅝	84⅝
2,614,820	Stock	...	Do. Deferred	16 16½	...	February	16½	16¼
130,000	£10	5/0	Brazilian Submarine	12 12½	6 0 0	Mar., June, Oct., Dec.	13⅜	12¼
112,900	£100	5%	Do. 5 per Cent. Bonds	101 103	4 16 9	January and July	...	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	106 109	4 11 9	June and December.	107½	...
16,000	10	9/0	Cuba Submarine	14½ 15	6 0 0	February and August	14⅝	14⅛
6,000	10	10/0	Do. Preference 10%	20 21	4 17 9	,, ,,	...	...
12,931	5	2/0	Direct Spanish (£4 paid)	3⅜ 4¼	3 15 4	March & September	...	...
6,000	5	5/0	Do. Preference 10%	9 10	5 0 0	April and October	...	...
60,710	20	3/6	Direct United States	10 10½	6 16 7	Jan., Apr., July, Oct.	10⅝	10
880,000	10	2/6	Eastern	13⅞ 14⅛	4 12 0	,, ,,	14⅛	13⅝
70,000	10	3/0	Do. 6 per Cent. Preference	15¼ 15½	3 16 2	,, ,,	15½	...
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock	106 108	3 14 1	May and November.	108	106
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	107 110	4 10 11	February & August	...	...
250,000	10	2/6	Eastern Extension	13½ 13⅝	4 14 6	Jan., Apr., July, Oct.	13⅝	13⅞
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	102 104	3 16 1	February & August	...	...
473,000	100	5%	Do. 5 per Ct. (Austrln. Gov. Sub.) Debs. 1900	104 107	4 13 6	January and July	105	104¾
179,177	10	2/0	Globe Telegraph and Trust	8⅝ 8⅞	5 15 6	Jan., Apr., July, Oct.	8⅞	8⅛
178,992	10	3/0	Do. 6 per Cent. Preference	14 14⅞	4 0 8	,, ,,	14⅞	14⅛
150,000	10	5/0	Great Northern	15½ 16	4 13 9	Jan., July, and April	16	15⅞
17,000	25	12/6	Indo-European	41 43	5 16 3	April and October	...	...
9,000	8	4/0	Reuter's	7 7½	5 6 5	April and October	...	...
15,609	10	5/0	West African Telegraph	9½ 10½	...	...	10⅜	...
300,000	100	5%	Do. 5 per Cent. Debentures	100 103	4 17 1	March & September	102½	100
30,000	10	5/0	West Coast of America	10½ 11	5 0 0	January and July	...	...
150,000	100	8%	Do. Debentures 8%	122 127	6 6 0	June and December	...	...
88,321	10	nil.	West India and Panama	2⅜ 3	...	...	3⅛	2⅛
34,563	10	12/0	Do. 1st Preference 6%	11⅜ 12½	...	April and October	12⅝	11⅛
4,669	10	+	Do. 6 per Cent. 2nd Preference	14½ 15½	...	...	15⅞	...
45,181	15	9/0	Western Brazilian	8¼ 8⅜	8 12 5	May & November	9⅛	8½
$1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	118 122	5 14 9	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	100 102	5 17 8	March & September	...	...
			TELEPHONES.					
224,850	14/0	5%	Consolidated Telephone and Maintenance	⅝ ¾	...	Yearly	...	...
220,000	£1	3%	Oriental (11s. paid)	1⅛ 1⅛	3 15 11	...	...	...
*	*	nil.	National	5⅜ 6	...	...	6⅛	5⅜
55,000	5	3/0	United River Plate	4⅜ 5¼	...	January and July	5⅜	...
			ELECTRIC LIGHT.					
23,692	5	2/0	Anglo-American (fully paid)	...	...	February & August	...	...
79,934	5	6%	Swan United (£3. 10s. paid)	4⅜ 5¼	4 0 0	...	5¼	4⅛
500,000	10	...	Metropolitan Electric Supply (£3 paid)	5¼ 5⅜	...	...	5⅛	5¼
			MISCELLANEOUS.					
37,350	12	12/0	Telegraph Construction and Maintenance	44 46	5 4 5	March and July	45	...
41,600	10	10/0	India Rubber, Gutta Percha & Telegraph Works	18½ 19½	5 2 7	February & August	19	18⅝

† No dividend since May, 1880.



Before Ordering!

ELECTRICAL PLANT & ACCESSORIES

WRITE FOR THE FOLLOWING PAMPHLETS TO THE

UNITED ELECTRICAL ENGINEERING CO., Ltd.

Head Offices: 3, Princes Mansions, VICTORIA ST., WESTMINSTER.

"ELECTRICAL DISTRIBUTION."—Commercially considered, with Estimates.

"MACHINE DRIVING BY ELECTRICITY."—The Uses of Electro-Motors for Traction and Stationary Purposes.

"THE TELPHER SYSTEM OF CHEAP TRANSPORT," for Minerals, Goods and Passengers.

"ELECTRICAL SUPPLIES."—Prices and Particulars of the most approved Electrical Appliances.

ELECTRICAL PLANT ON VIEW.

Digitized by Google

THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 602.—Vol. XXIV. FRIDAY, NOVEMBER 29, 1889. Price Fourpence.

NOTES.

We learn that Sir James Anderson, Sir Albert Cappell, and Sir Henry C. Mance have been invited to allow themselves to be nominated for the Council of the Institution of Electrical Engineers for the ensuing Session. These gentlemen being prominent representatives of cable and telegraph interests, their election on the Council would afford much satisfaction to a large section of the members, and go far to allay the irritation which has lately found expression in our columns.

The question has occasionally been asked, how it is that there is no one on the Council of the Institution of Electrical Engineers who can be said to represent the telephonic interests? It is not a new complaint; but the non-representation of telephone men is even more striking than the small representation of cable men to which attention has lately been called. We believe that the true reason for this strange state of things is as follows; at least we have it on the authority of one who ought to know:—During the time that the late United Telephone Company was waging legal war on all competitors, permission was refused to any of the persons in the employ of the United Telephone Company to read scientific Papers at the Institution on telephonic matters; and more than this, the *employés* of the United Telephone Company were actually *forbidden* to attend the meetings of the Society. American telephonists who contrast this with the active part taken by telephone men on their side in the business of the American Institute of Electrical Engineers, and other electrical bodies, will now perhaps comprehend why progress on our side has been so slow.

The reply of Mr. Lee Babty to the report of the Special Committee of the Electrical Trades Section may be deemed, except on the one important question of insurance, as fairly satisfactory. If the Executive Committee of the Exhibition persist in their refusal to undertake the insurance of exhibits, it is to be hoped that they will, at least, see their way to minimise the insurance premiums by erecting weather and fireproof buildings, and by organising an efficient fire brigade.

We think it is to be regretted that the Exhibition authorities were unable to do more than offer to supply the power in the event of electrical tests being undertaken. The cost of such tests would, no doubt, be considerable, but their scientific and commercial value would be great. Exhaustive tests by a competent jury of the alternators and transformers of the leading English and American makers would, we think, be a feature likely to contribute largely to the general success of the Exhibition.

On another page we give Mr. Brooks' views as to the Brooks' System. For telegraphic and telephonic purposes that system has, we believe, given very good results, and it is to such work that most of Mr. Brooks' observations specially refer. Our readers will note that little or nothing is said by the originator of the system as to any modifications that may be necessary to adapt that system to the very different conditions obtaining when the object is to put down, to protect, to repair, or to replace the heavy conductors that are demanded in connection with electrical distribution as understood by the "heavy electrical engineer." The subject is an exceedingly important one, especially at the present time, when very large sums of money are being expended in underground work. Even from the point of view of the proverbial "man in the street," there seems to be room for considerable improvement in some of the work and methods that may be inspected daily in London. We trust that we are not mistaken, but we are forced to one of two conclusions by our observations—either that before long considerable repairs will be required, or that the laying of underground conductors in a permanently satisfactory way is a much easier matter than has generally been believed.

Whether Mr. Brooks' system, when used for large currents and high electromotive forces, will be quite satisfactory we shall be very glad to learn, not from an *ex parte* statement, but from some account of its prolonged use on a practical scale. We imagine, however, that before it has any chance of being tried in this country a large number of special devices and arrangements must be prepared to fit it for the conditions that exist in connection with town lighting, not the least of which will be to provide suitable means for frequent tapping of the mains—though we do not, for our part, anticipate any very serious difficulties in this matter.

Electrical tramways have hitherto been worked according to one or other of the following plans—aerial conductors, rail conductors, conductors in conduits with open slot, and accu-

Digitized by Google

mulators. Each of these plans has advantages—and disadvantages. There have at various times been indistinct rumours of systems that professed to have all the advantages and none of the disadvantages of conduits. Such a system is undoubtedly attainable, if high first cost is not included among the disadvantages. We give this week a short description of a method which is a closed conduit method, and we draw the attention of electrical tramway men to it as at any rate pointing in a direction that appears to invite careful examination.

THE National Telephone Company is threatened with opposition in several of the principal provincial towns by a project for establishing what is called Co-operative Telephony, all the users binding themselves together to pay the cost, and no more than the cost, of erecting and working wires of their own. We cannot be sure of the *bona fides* of the proposal, for we find the same financial organs which not long ago were encouraging the telephone companies in their amalgamation now backing up the rival scheme as being directed against a gigantic and mischievous monopoly whose patents are happily expiring. Of one thing, however, we are pretty sure: the new competitors will have to gain the consent of the POSTMASTER-GENERAL; and, patents or no patents, will have to pay royalty to the Post Office.

IN a long letter to the *Scottish Leader* of the 20th, Mr. A. B. BROWN, of Rosebank Electric Works, discusses, for the benefit of the Edinburgh Town Council, the various existing systems of electrical distribution. The alternate-current high-tension system is dismissed on account of its danger, anent which Mr. BROWN remarks: "I do not think it rash to forecast the probability that in the end, and that is not far distant, this system will be prohibited by law." For our own part, remembering, as we do, that there have been alarmist proposals to limit train-speeds, boiler-pressures, and what not, we do not think it rash to predict that such a prohibitory law will never be placed upon the Statute book. If experience shows that the dangers of a high-tension alternate-current system of distribution are greater than its advantages, its extinction will be automatic, and legal prohibition will be quite unnecessary. The next system which is weighed by Mr. BROWN and found wanting—this time owing to its costliness—is that of battery sub-stations. This process of elimination leaves us "the 100-volts, harmless, simple, continuous system," which, with the dynamos worked by "a highly explosive, but non-illuminating gas," to be supplied by the Gas Commissioners to the various centres, in separate pipes, is the circumlocutory method of distribution which, in Mr. BROWN'S opinion, ought to find the most favour with the Edinburgh authorities.

WE hear that Messrs. W. T. GOOLDEN AND CO. are now constructing a modified type of continuous-current dynamo, the special feature of which is that the armature and field-magnet poles are so disposed that, in the event of any coil burning out, it can be at once replaced *in situ* by any intelligent workman of ordinary skill.

NOTHING daunted by the untimely fate of the Electric Subway Railway Bill in the House of Commons last Session, it is proposed next year to bring forward a somewhat similar scheme. Last year the idea was to run a spacious subway a few feet below the roadway, the line starting in the neighbourhood of Piccadilly and terminating in the heart of the City. The present proposal is to pierce the London clay at a depth of 40 or 50ft. with two steel tubes, after the fashion of the City and Southwark Subway, and to run a line from Queen's-road, Bayswater, to the King William-street terminus of the City and Southwark Subway. The engineers are Sir JOHN FOWLER, Mr. BENJAMIN BAKER, and Mr. GREATHEAD; and we think it will be pretty generally agreed that the carrying out of the scheme could not be in better hands.

DO any of our studious readers ever consult that most interesting volume, the Catalogue of the Ronalds' Library? They will find many curious entries, some of great value, others of a singularly trivial nature. "On the Electricity of a Parrot's Wing" is the title of one of the items. Another title entered in the catalogue is "The Desideratum, or Electricity made Plain and Useful, by a Lover of Mankind and of Common Sense." The author of this curious work is no other than the Reverend JOHN WESLEY. The date of the book was 1759, but it appears to have been reprinted as lately as 1871.

OUR esteemed contemporary the *English Mechanic*, which does so much to bring practical science within the comprehension of the non-technical, and which is virtually the organ of communication between scientific amateurs of all ranks, is just now enlightening its readers respecting the "new" theory of sound originated by Dr. A. WILFORD HALL. The new theory, which is to demolish the wave theory, is that sound consists of corpuscles of different sizes that fly through space. How they fly through solid wires remains to be told in a future number, the issue of which we await with interest. In particular we want to learn how telephonic sounds are transmitted. Are the corpuscles that come out of the speaker's mouth transmitted "in a fluid state" through the electric wires, or do they merely set up electric disturbances which breed at the distant end a new crop of corpuscles? We crave for a clear and full explanation.

THE rumour that Mr. J. E. H. GORDON had ceased to be engineer to the Metropolitan Electric Supply Company is, we hear, without foundation. When the Metropolitan Company was formed Mr. GORDON was appointed head of the engineering staff as a salaried officer, and undertook both the work of designing new and working completed stations. Owing, however, to the rapid development of the Company's operations it was recently decided to make a division of duties, the designing and carrying out of new work being left in the hands of Mr. GORDON, while the general management of the engineering department was given to Mr. BAILEY, who has for some time past afforded valuable assistance to Mr. GORDON, who still remains engineer to the Company under an arrangement usual in such cases.

Digitized by Google

Morecambe.—Application has been made by Messrs. Andrews and Preece, of Bradford, for a Provisional Order.

Salonica.—The *Revue de l'Orient* of Budapest states that several offers have been made to light Salonica by electricity.

Darlington.—At a special meeting of the Town Council last week, it was unanimously resolved that application should be made for an electric lighting Provisional Order.

Personal.—On account of Mr. Fahrig's indisposition, the demonstration and lecture on "Ozone," at the Ozone Works, is postponed. Invitations will be re-issued at soon as convenient.

The Lighting of the City.—Notices of application for electric lighting powers within the City were published this week by the Brush Company and the London Electric Supply Corporation.

St. Helens.—The Town Council has decided that steps shall be taken to apply for a Provisional Order to supply electricity in the districts within the area of the gas supply of the Corporation.

Royal Institution.—The Christmas lectures (adapted to a juvenile auditory) will this year be given by Prof. A. W. Rücker, F.R.S., on electricity. They will commence on Saturday, December 28th.

Electric Traction on the North Metropolitan Tramways.—The North Metropolitan Company have this week advertised their intention of applying for powers to work the whole of their system by electricity.

Newcastle.—The Town Clerk has been instructed to confer with the representatives of the electric lighting companies with a view of arriving at an agreement which will empower them to proceed with their work.

Chatham.—The Admiralty have decided that Chatham Dockyard shall be lighted by electricity, and have directed preparations to be made for the lighting of the ships and workshops with the new illuminant.

Electric Traction at Doncaster (Victoria).—An electric tramway, 2¼ miles in length, on the overhead Thomson-Houston system, has come into operation at Doncaster (Victoria). A pressure of 400 volts is employed.

Havana, Cuba.—The electric lighting plant of the Spanish-American Gas, Light, and Power Company, of this city, now comprises three 1,500-light Westinghouse alternating machines, and six 50-light Thomson-Houston arc machines.

Surbiton.—At a special meeting of the Improvement Commissioners last week, it was agreed that application should be made, in combination with the local authorities of Kingston, New Malden, and Hampton Wick, for a Provisional Order.

Proposed Electrical Exhibition at Frankfort.—The Electrotechnical Society of Frankfort has unanimously decided to hold an electrical exhibition in this town next year, and a committee of eighteen members has been formed to take the necessary steps.

Barnsley.—At the last meeting of the Town Council the draft Provisional Order presented by the Town Clerk, which had been thoroughly revised by competent parties, was ordered to be printed and placed in the hands of all the members of the Council.

A Correction.—In our note last week on the electric lighting of Alnwick Castle, the batteries were stated to be E.P.S. type. We are, however, informed by Messrs. Drake and Gorham that they are the same pattern which have been fitted by them in so many installations.

Mill Lighting.—Thorverton Mills, Devonshire, which have been fitted up with every improvement in the matter of turbines and rollers, have now been lit by electricity. This work has been carried out by the firm of Messrs. Christey, Son, and Norris, of Chelmsford.

The Electric Light at the British Museum.—Most of the galleries in the British Museum will, it is stated, be open to the public, commencing 1st January next, from 10.0 a.m. to 10.0 p.m. The electric lighting is now ready, new machinery having been put in and tested.

The Copper Market.—The price of copper is again rapidly rising, in consequence, it is said, of the abnormal purchases of the German and French Governments, who have decided to reconstruct their naval and military ordnance, replacing steel, to a large extent, by gun-metal.

Padiham.—At the last monthly meeting of the Local Board it was intimated that the two electric lighting companies who had given notice of applications for Provisional Orders had withdrawn the same, and the Board decided not to proceed with their application for the same powers.

Ealing.—The application of the Maxim-Weston Company for consent to their proposed Provisional Order was discussed at considerable length at the last meeting of the Local Board. It was finally decided to adjourn the meeting, with the view of obtaining advice from the Board of Trade.

Dundee.—At a meeting of the Electric Light Committee of the Town Council, Police Commission, and Gas Commission on Monday, it was agreed to take the opinion of Dr. Hopkinson, as to the expense and all other matters connected with the installation of a system of electric lighting in Dundee.

The Electric Lighting of the Houses of Parliament.—The contract for lighting the Houses of Parliament by electricity has been given to the Westminster Electric Supply Corporation, and active steps are being taken to carry it into effect. It is proposed to make a large extension of the existing installation.

The Chair of Engineering in Yorkshire College.—The Council of the College have elected Mr. John Goodman to succeed Prof. Barr in the chair of Civil and Mechanical Engineering. Mr. Goodman, who is 27 years of age, is at present chief assistant at the Broadway Testing Works and Chemical Laboratory, Westminster.

The Telephone in Kent.—The South of England Telephone Company are just finishing an extension of their system at Deal, Kent, and the wire to Whitstable will be opened in another fortnight. The Ashford Trunk Line will then be commenced, prior to opening up communication between Maidstone, Chatham, and East Kent.

Tynemouth.—At a meeting of the Town Council last week it was decided not to proceed further with the application for a Provisional Order. The action of the Council is based upon the withdrawal from action in the matter by the electric lighting companies who had previously intimated their intention to apply for powers.

Technical Education.—At a Conference of the National Association for the Promotion of Technical Education, held at the Manchester Town Hall last Tuesday, a report was read by Sir Henry Roscoe, showing that a large number of towns throughout the kingdom have already adopted, partly or wholly, the Technical Instruction Act of 1889.

The Lighthouse Illuminants Inquiry.—Sir William Thomson has been selected by the Board of Trade to take the place of Sir William Grove on the Committee appointed to inquire into the correctness of the allegations of shipowners and others against the conclusions of the Trinity House report on the South Foreland experiments with lighthouse illuminants.

The Central Station at Tivoli.—The plant of the central lighting station now in course of erection at Tivoli will comprise six 350 horse-power Girard turbines and three 50 horse-power Girard turbines; six 5,100 volt 45 ampere alternators and three 180 volt 150 ampere machines. The station is expected to be ready to supply current by August next.

Worcester.—At a meeting of the Watch Committee last week a report was received from the Gas Sub-committee with regard to the proposed application for a Provisional Order, proposing that the compulsory district should have a total area of about 103,000 square yards. The sub-committee estimated the capital expenditure at £15,000. The report was adopted.

Festivity.—A complimentary musical *soirée* and ball was given at the Manchester Athenæum on Tuesday evening to commemorate the marriage of Mr. Kenneth Maciver, Manager of the Manchester district of the National Telephone Company. Mr.

Digitized by Google

Maciver was presented during the course of the evening with a gold repeater, and Mrs. Maciver with a fine pearl and diamond ring.

Carlisle.—The Corporation have been advised by the Town Clerk that the powers granted to them in the electric lighting Order, obtained by them several years back, have not lapsed through non-usage, but are perpetual. Acting on this supposition, the Corporation do not intend to apply for a new Provisional Order, but propose to take steps to supply electricity under their old powers.

Civil and Mechanical Engineers' Society.—On the 13th instant Messrs. David Kirkaldy and Sons received the members of this Society at their testing and experimental works in Southwark-street. Tensile tests were carried out in the presence of the visitors, who were next shown the well-arranged museum, containing specimens of every kind of material, which had been submitted to every kind of stress.

Institution of Electrical Engineers Students' Meeting.—At the students' meeting on Friday last a discussion took place on "Cotton, Jute, and other Fibrous Substances as Insulators," in which Messrs. Barton, Childs, Muir, Müller, Poynton, Tonge, and Walker took part. This was followed by a description by Mr. Childs of the pumping and hauling plant recently put in at St. John's Colliery, Normanton.

Leicester.—At a meeting of the Town Council on Tuesday a motion for the appointment of a Special Committee to report as to the best means of improving telephonic communication in the town was carried by a large majority. Great dissatisfaction was expressed at the restrictions which the Post Office seek to impose upon the use of the telephone, and it was proposed to ask the National Telephone Company to start an exchange.

Proposed Memorial to Dr. Joule at Manchester.—The Mayor of Manchester, in reply to a deputation of the Manchester Literary and Philosophical Society, who presented a requisition asking that he would hold a public meeting to consider the raising of a permanent memorial to the late Dr. Joule, said that he was entirely in accord with the purpose of perpetuating the great name of Dr. Joule. He would further the object in any way he possibly could.

A Smart Telephone Performance.—The *Cardiff Evening Express* mentions the following as an instance of smart work by the Western Counties and South Wales Telephone Company:—"It was three minutes after the game between the first teams of Cardiff and Gloucester had finished that the result was handed in at the telephone office, Working-street. In ten seconds the result was sent through the Gloucester office, where a large number of persons had assembled."

An Electric Tramway in a Distillery.—An electric tramway has been in operation for some little time at the Dublin Whiskey Distillery. The line is circular, and is about one mile in circumference. An overhead wire is used and current is obtained from the electric light dynamos. At present the principal use to which the railway is put is to carry the barrels of whiskey from the distillery to the bonded stores, but arrangements are being made by which the grain can be brought from place to place.

The Electric Light on the Suez Canal.—An official return shows that in the year 1888 the time occupied in passing through the Suez Canal by vessels not using the electric light was 37 hours 57 minutes on the average, whereas the average time occupied by vessels using the electric light, and thus being able to navigate the canal by night, was 22 hours and 32 minutes. The number of vessels passing through the canal by the aid of the electric light increased month by month with remarkable regularity; their number for the first three months was 295, whereas for the last three months of the year it was 516.

The Determination of Air-Temperatures at Great Heights.—For determination of the air-temperatures at great heights, the Berlin Society for Ballooning proposes to try a method of Herr Siegsfeld, who uses a thermometer, which, by closure of an electric circuit when certain temperatures are reached, gives a light-signal. Small balloons, each containing such a thermometer, will be sent up by night, and the light will affect photographically a so-called "photo-theodolite," while the height then attained will be indicated in a mechanical way. It is hoped that more exact formulæ for the decrease of temperature with height may thus be obtained.

Berlin.—According to the Berlin correspondent of *Industries*, the Berlin municipal authorities having formally sanctioned the contract to be entered into with the "Berliner Elektricitäts-werke," the latter have to at once increase their means of supply at the central station, now in course of construction, up to 28,000 horse-power, and to extend their mains to the limits defined in the contract of August, 1888. The Company is bound to supply currents on demand to every householder in the streets through which their cables run. The Monnier conduit is being extensively introduced for the conveyance of underground electric light wires.

The Telephone Company of Rio de Janeiro.—The concession of the present Company was to expire on the 31st ult., but there appeared to be little likelihood, according to advices of the 28th ult., that it would be able to dispose of its plant. From the fact that on October 24th seven new proposals were opened at the Department of Agriculture for the construction of telephone lines in the city, it looks as though the Government had decided to ignore altogether the wires of the old Company. Just as the mail left there was a rumour that the Company had succeeded in privately disposing of their lines, posts, and other material for a sum of 400,000 milreis (£45,000).

St. James's (Westminster) Vestry.—At the last fortnightly meeting of this Vestry, the Lighting Committee reported that the London Electric Supply Corporation had secured, to the satisfaction of the Board of Trade, the sum of £13,000, the amount stipulated in their order, and that they were in a position to discharge the duties and obligations imposed upon them. They recommended that no objection be offered to the laying of mains by the Corporation, but that they should be requested to proceed as rapidly as possible with the work, in order that the surface of the streets affected thereby might be reinstated before the opening of Parliament. The report and recommendation were carried unanimously.

Railway Signal Devices.—We described in our issue of September 13th some ingenious electrical railway signal devices due to Mr. Henry J. Peddie, of Edinburgh. By means of one the brake was automatically applied to a train accidentally "running the signal," and by means of the other the signalman was able to trace the passage of the train along his particular section. Mr. Peddie's latest device is one which causes alarm bells to be rung and danger lamps to be lighted, both in the signal cabin and on the engine, whenever a danger signal is passed. Devices of this description are by no means new, but they have hitherto failed to come into general use, their expense, doubtless, proving a formidable deterrent.

A Peculiar Earth.—A peculiar earth, very similar to that which recently occurred in Boston and which was alluded to in *The Electrician* of August 9th, was discovered some few weeks ago on the Boulevard des Capucines. As at Boston, it was noticed that horses manifested considerable uneasiness on passing over a particular portion of the roadway. The electric light company was communicated with, and on the roadway being dug up it was found that the lead cover of the branch conductor to the street lamp was in contact with one of the bare main conductors, and as the neutral wire was faulty in several places a circuit was completed through earth between the lead cover and the neutral wire. The iron hoofs of the horses made excellent contact with the damp wood of the roadway, and the unfortunate animals consequently became a shunt on this leakage circuit and received smart shocks.

The Institution of Civil Engineers.—The following are some of the subjects on which the Council of the Institution of Civil Engineers invites original communications:—The Utilisation of Unused Sources of Power in Nature—such as the Tides, the Radiant Heat of the Sun, &c.; recent Improvements in Cable and Electrical Tramways; Mechanical Traction on

Digitized by Google

Common Roads; the Petroleum Engine and its Applications; the best Combined System of Warming, Ventilating, and Lighting large buildings; Electric Meters for recording the Consumption of Electrical Energy; the Construction and Maintenance of Secondary Batteries; the Application of Electricity to the Working of Cranes, Pumps, Tools, &c.; the Application of Electricity to Smelting and Metallurgical Operations; the Application of Electricity to the Purification of Water and of Sewage; the Purification of Copper, and the Reduction of Copper Ores by Electrolytic Processes.

Electric Alarm Advance Car.—A Mr. Harry Riesenberg, of St. Louis, Missouri, has devised an apparatus which he designates an "electric alarm advance car." Mr. Riesenberg proposes to send on in front of every railway locomotive a supporting car and pilot car. The pilot car receives its motive power from an electric motor thereon, which latter obtains electric energy through a cable from a dynamo on the locomotive. The pilot car is run at a higher speed than the train itself, and this keeps the cable tight and off the ground, and also propels the centre supporting car, which is attached to the cable midways between the front part of the engine and the rear end of pilot car. The cable contains, besides the wires for transmission of the current produced by the dynamo, also two wires which form an electric-bell circuit. If anything should happen to the pilot car the bell at once rings and warns the engineer. The same thing was, however, proposed last year by an Austrian engineer.

The Hussey Bluestone Battery.—This battery is an improved Daniell. The copper electrode is made in the shape of a thin circular disc, and is laid at the bottom of the cell. The porous jar containing the zinc electrode is glazed on its outside from top to bottom to render its sides non-porous, while the bottom being unglazed is porous. The jar is provided with legs, and rests on the copper disc. The outer jar is filled with copper crystals and solution to a little above its centre. The solution in the porous pot is kept at a higher level than that in the glass jar, consequently the pressure on the inner surface of the porous bottom is downward, so that the copper solution cannot get into the porous cup and come into contact with the zinc. The E.M.F. of the cell is 1·1 volts and its internal resistance is about ·22 ohm. It is claimed for this form of cell that there is absolutely no deposit of copper on the zinc, and amongst other advantages the zinc consumption is said to be very low.

Electricity in the Mine of St. Mauritius.—The following is extracted from the monthly report of the resident engineer:—"All is being arranged with a view to adapting water as a motive power in preference to steam, by which, latterly, the whole mine was worked at a great expense, both in the matter of skilled labour and in coal. The water will be collected in a large tank which will shortly be erected, and from this tank it will be conducted in wrought-iron pipes down the day shaft—a vertical fall of 260ft. to the turbine, which is already on the spot for erection. The positions for the turbine and the dynamo it drives are already determined, and the foundations, &c., are being prepared. With such a fall, with a plentiful water supply, the power of the turbine will be very great. The power of the dynamo will be transmitted to the pump shaft for pumping and winding purposes by means of cables and motors, supplied by Messrs. Immisch and Co., of London. Besides the above we shall probably have the advantage of electric light."

The Determination of Dielectric Constants by Means of the Telephone.—The specific inductive capacity of various substances have been determined by Winkelmann in the following manner:—Three insulated brass discs were arranged parallel to one another. The central disc had the same thickness as the two outer ones, but its diameter was one-half smaller. The outer discs were movable along a graduated support. The central disc was connected to one end of an induction coil, the other end of which was placed to earth. When the two outer plates were joined up through a telephone, there was a minimum of sound on the induction coil being brought into play whenever the central disc was equally influenced. The minimum was clearer the nearer the plates were together. Having determined the position of the minimum sound, a sheet of some dielectric substance was next interposed between the central disc and one of the outside plates, one of which was then moved until a minimum of sound was again obtained. If a is the distance of the two outside plates from the central disc before the introduction of the dielectric, and d is the thickness of this latter; D being its specific inductive capacity, and x the distance through which it was necessary to move the plate to restore equilibrium after the interposition of the dielectric substance, then we have $a - x = a - d + \frac{d}{D}$, whence $D = \frac{d}{d-x}$. In spite of the small error due to the difficulty of exactly determining when the minimum sound was given by the telephone, the results obtained for solid bodies and for liquids agree substantially with previous determinations.

The Edinburgh Exhibition.—On Saturday afternoon last the ceremony of cutting the first sod on the site of the International Exhibition to be held in Edinburgh next year, took place in presence of a large assemblage. Sir Thomas Clark said he believed that some people had an idea that this Exhibition had been introduced rather too soon after the Exhibition of 1886, but there had been very good reasons for it. They had promises from all parts of the world in this respect, and the little difficulties that were in the way with the London Chamber of Commerce had, he believed, all been got over, and now there would be a unanimous feeling throughout the whole of the electrical world that this Exhibition should be made a great success. The ceremony was then performed by Lady Clark. On Monday last there was a meeting at the Mansion House of the London Committee, recently formed in connection with the Exhibition. Sir George H. Chubb, the chairman of the London Committee, said it had been thought desirable to form that committee in connection with the Exhibition to give to those undertaking the arrangements the benefit of their advice and experience. Mr. G. E. Watson, the secretary of the Exhibition, said the guarantee fund amounted already to £23,000, and the buildings would cost £35,000 or more. The Exhibition would be open from May 1st to November 1st, and applications for space would be received until January 1st next. Mr. C. M. Kennedy, C.B., of the Foreign Office, moved a resolution commending the Exhibition to the support and co-operation of the public. The resolution was carried, and at the instance of Captain Shaw, C.B., a sub-committee for London was appointed, and the proceedings then closed.

National Telephone Electrical Society.—At the meeting of this Society on Friday evening, the 22nd inst., Mr. Arthur E. Cotterell, Vice-President, read a very interesting Paper on "Disturbances on Telephone Circuits." The Paper was illustrated with diagrams showing, *inter alia*, the various devices that have been adopted on telephone circuits with the object of minimising the effect of induced currents. Among the causes to which Mr. Cotterell assigned the disturbing effects experienced on telephone lines may be mentioned microphonic action due to unsoldered or "bad" joints, earth currents traversing the lines, induction due to adjacent earth plates, galvanic action, the result of using earth plates of dissimilar metal, and, of course, the ordinary induced effects due to currents from adjacent wires. Mr. Cotterell said he had found that in a cable, induction decreased almost in proportion to the number of wires in the cable having a "ground" connection at each end, from which he inferred that cables with as large a core as possible "earthed" at either end would be most suitable. A metallic earthed sheathing on the wires has a very beneficial effect. He relates a curious instance as worthy of further investigation, where the induction on two adjacent private wires was materially diminished by severing the pole earths. With regard to metallic circuits, he pointed out the useful effects derived from having a metallic sheath on the induction coil where a loop is joined to a single wire, and the necessity of keeping both arms of the loop line equally balanced to avoid the bad results recently obtained through one of the arms of the metallic circuit between Birmingham and the North of England having a bad joint. The Paper was a record of practical experiences, such as cannot fail to assist others in overcoming the many difficulties which surround the construction and maintenance of telephone networks.

Digitized by Google

ON THE DISTRIBUTION OF ELECTRIC ENERGY BY MEANS OF CONSTANT CURRENT.

BY ALEXANDER BERNSTEIN.

The energy of an electric current is the product of the strength of the current multiplied by the difference of potential at the ends of the conductor. Corresponding to these two values we have two general systems of electrical distribution—in the one the current, and in the other the difference of potential, is kept constant. Although a combination of the two systems is possible, such combination has so many difficulties, without apparent advantages, that we always employ the two simple systems. In both systems the incandescent lamp of normal candle-power is a characteristic feature. The system of constant potential requires lamps of high tension and small current, which are placed in parallel between the conductors. The system of constant current requires lamps of small tension and large current, which are arranged in series one after the other. The fundamental idea of the parallel system is the maintenance of a constant difference of potential between two conductors of electricity. As a matter of fact, this condition can only be fulfilled as long as there is no current in the conductors, but as soon as the current commences to flow we must necessarily have a variation in the tension on different parts of the line, a defect which can never be entirely overcome. This fundamental error in the theory of the system makes itself very much felt as soon as we have to deal with larger plants. In order to obtain an approximation to constant potential in the conductors under varying loads and long distances, we are forced to make use of a complicated and expensive system of conductors, and of a variety of arrangements for regulating the tension, which require constant supervision. The large number of proposals which have lately been brought forward in order to overcome this difficulty in the system of constant potential, show very distinctly that the problem has not yet received a satisfactory solution, which is not surprising, as a complete solution is a matter of impossibility. The use of incandescent lamps in parallel requires constant potential, as a small rise in potential between the two conductors very materially affects the life of the lamp, and a decrease reduces the light considerably, although the consumer has to pay about the same price as for a full candle-power lamp.

It is totally different if we have a system worked on the principle of constant current. Here the fundamental idea is theoretically correct, and is capable of being carried out in practice, entirely independent of the distance which we have to overcome. The practical advantages of such a system have induced me (already in 1882) to turn my special attention to this matter, and it is the purpose of this Paper to describe the system, as worked out by me, in its present state.

I shall commence with the description of a simple circuit in which glow lamps are placed in series, such a circuit as shown in Fig. 1. In this figure the steam-engine A is shown driving a dynamo B, the conductor is marked C, and in this conductor the glow lamps D D are placed one after the other. Now, the first condition in the case of such a system is the maintenance of constant current independent of the resistance of the circuit; that is, independent of the number of lamps in use. The fulfilment of this condition appeared at first to offer considerable difficulties, which were, however, overcome in a very satisfactory manner. Constant current on the line means variation of E.M.F. in the dynamos according to outside resistance. Now, the E.M.F. of a dynamo can be varied in several ways—for instance, by variation of the magnetic field, or by altering the position of the brushes; but both these methods have their defects, and especially the latter, which is open to many objections. The much better way of altering the E.M.F. consists in varying the speed of the dynamo, and this method contains advantages which cannot be obtained in any other way. If a series dynamo is driven by a steam-engine from which the centrifugal governor has been removed, then this combination has in itself a tendency to produce constant current on the line; this means the steam-engine will run fast if there are many lamps on the circuit, and will reduce its speed if the number of lamps is reduced. To most engineers this always appears so singular that I shall explain the action in a few words.

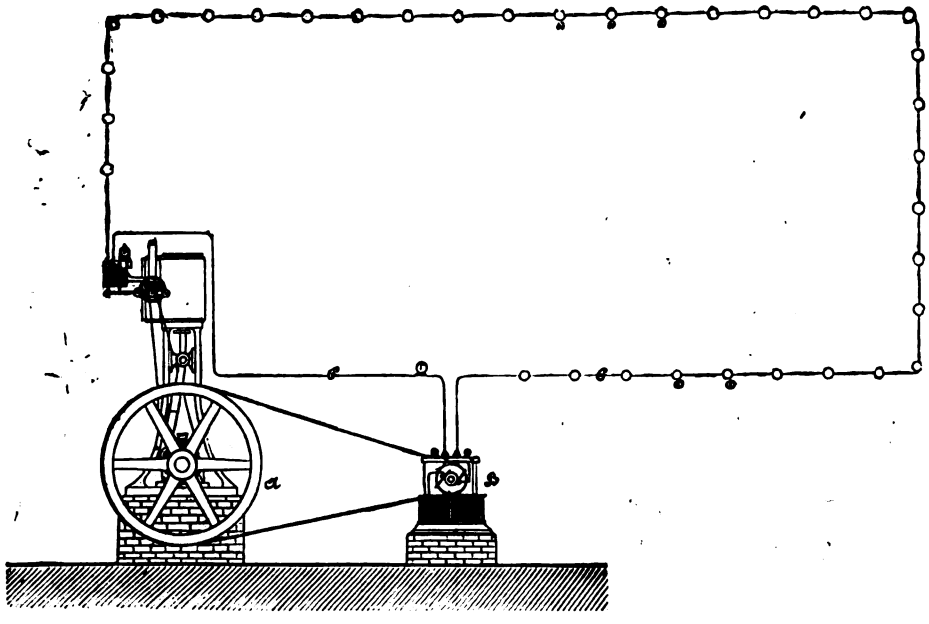


FIG. 1.

We are dealing here with a dynamo which has a field of constant intensity, and under these circumstances the E.M.F. and therefore the current produced is equal; outside resistance is simply dependent on the number of revolutions of the armature. The strain on the belt which is necessary to maintain the armature in rotation is dependent on the current, and quite independent of the E.M.F. This strain is produced by the pressure of the steam; therefore, if the steam pressure is given, the strength of current in the armature is determined which will counterbalance this pressure on the piston. I shall suppose that a state of equilibrium is maintained if the steam-engine makes 100 revolutions, and the current is equal to 10 amperes. Now, if lamps are added, the outside resistance would increase, and therefore the strength of the current would be diminished. This has the effect of disturbing the equilibrium; the current is too weak to counterbalance the steam pressure, which we assume is constant, and the engine commences to move faster until equilibrium is again produced; this is as soon

Digitized by Google

as the current has again reached 10 amperes. The reverse would take place if we diminish the number of lamps on the circuit. If we, therefore, use a steam-engine without centrifugal regulator, driving a series dynamo, we can obtain constant current in the circuit, provided that the steam pressure in the cylinder remains constant. This method of regulation was first put to practical use by me about three years ago, and has since then been adopted by others. As, however, the pressure in the cylinder cannot be relied upon as constant, and as this pressure, moreover, varies with the speed of the piston, it becomes necessary to use an electric regulator, in order to correct the irregularities in current which would otherwise result. I shall first describe the construction of the regulator which I am now using.

The regulator, Fig. 2, contains a well-balanced steam valve moved by a spindle, which carries the friction wheel A. A small rope pulley, B, is situated underneath the shaft of the friction wheel A, and this pulley is kept revolving from the shaft of the engine. The shaft of pulley, B, carries a lever, C, which contains the bearings for two small pulleys, D and E. These pulleys are connected in such a way with B that one is driven by an open, the other by a crossed belt. Small friction rollers are attached to the pulleys D and E, and, according to the position of the lever C, these rollers may come into contact

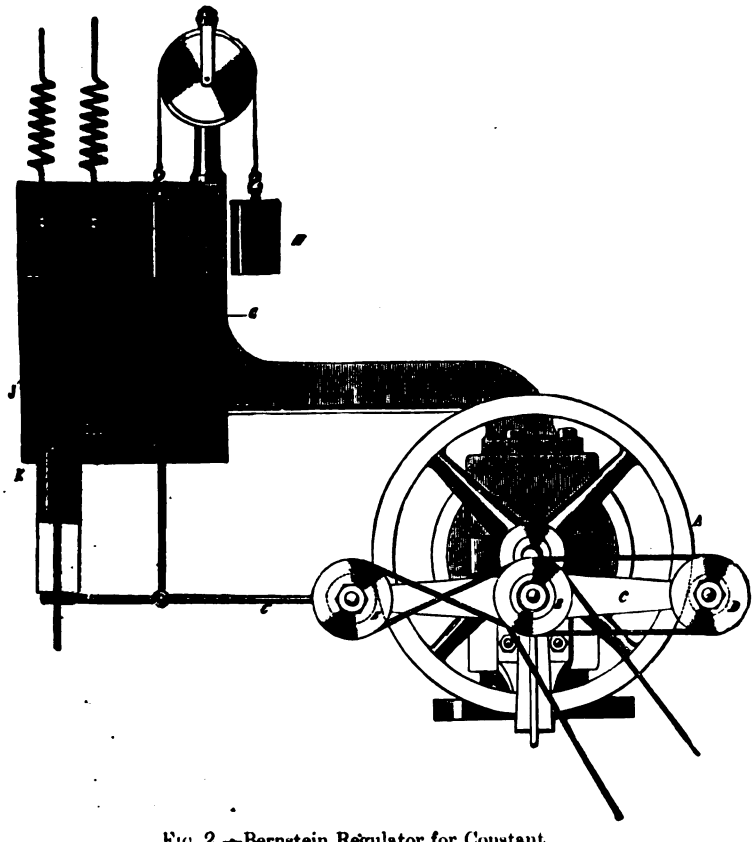


Fig. 2.—Bernstein Regulator for Constant Current Working.

with the wheel A. The position of the roller depends on the position of the iron core F, inside the solenoid G. The current which is to be regulated passes through this solenoid, and the counter-weight H is adjusted in such a way that the lever C is held in a horizontal position if the current has the normal strength. If the current were to increase, the iron core would be drawn further into the solenoid, the friction roller D comes into contact with A, and the opening of the valve is reduced until the normal strength of current is again established. The reverse takes place if the current becomes too weak, in which case the friction roller E is brought into action. It will be noticed that the power necessary to move the valve is supplied by the engine, the current merely directing the force. As the engine has no centrifugal regulator, it is necessary to prevent its running away if a belt should break, or the current be otherwise interrupted. For this purpose the regulator contains a second solenoid, J, with fixed iron core, which carries the weight K, if the current has approximately the normal strength, but if this current is interrupted the weight drops and rests on the lever C, the friction roller D comes into contact with A, and the valve is closed by the engine. I might remark that the falling weight has to my knowledge been first used by Messrs. Robey and Co. I mention this fact in order not to produce the impression that I claim priority on this point. The regulation by means of varying the speed of the engine is not only perfect, but it presents advantages in regard to economy which cannot be obtained in any other way, This method is only applicable to a system of constant current; if it is desired to maintain constant potential, the speed of the engine has to be kept nearly uniform. Now this has the disadvantage that we are only working economically if the engine is exerting its maximum power. With a certain steam pressure there is a certain degree of expansion at which the consumption of coal

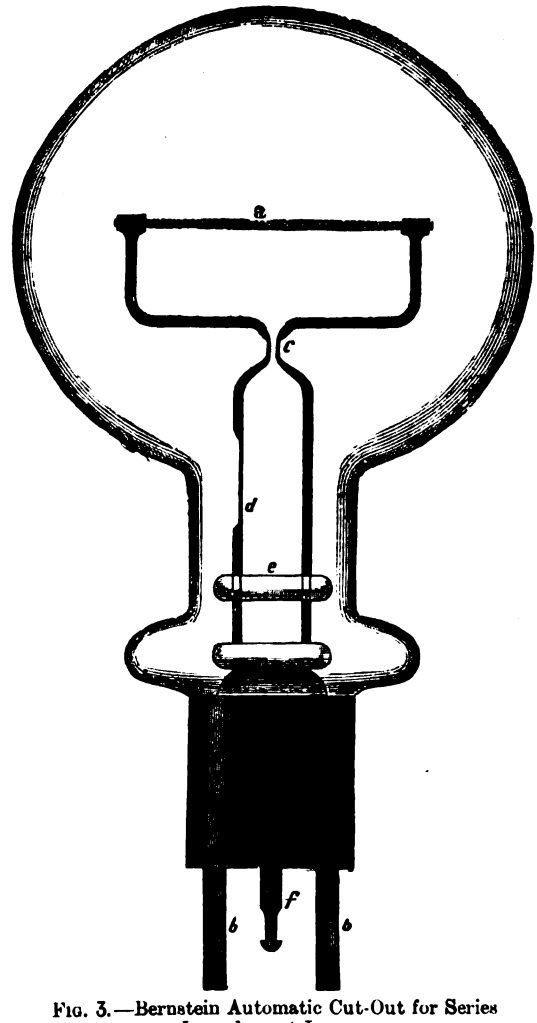


Fig. 3.—Bernstein Automatic Cut-Out for Series Incandescent Lamps.

is a minimum. If we use this highest degree of expansion when the engine is doing its maximum work, we are often working against the pressure of the atmosphere if we reduce the power of the engine. Very different in the above mentioned method of regulation: the velocity alone varies, the advantage of the expansion always remains the same. A steam-engine of 100 horse-power consumes 15—20 horse-power in order to run at full speed without doing any useful working. This means 15 per cent. loss at full power, 30 per cent. at half power, &c.; in fact, all motors are very uneconomical if they have to maintain full speed without doing maximum work. A gas-engine, for instance, consumes at half load five-sixths of the amount of gas which is required at full load. Lastly, the wear and tear remains about the same as long as the speed is the same; but if we adopt the method of varying the speed, the internal work and the wear and tear is about in proportion to the useful work,

Digitized by Google

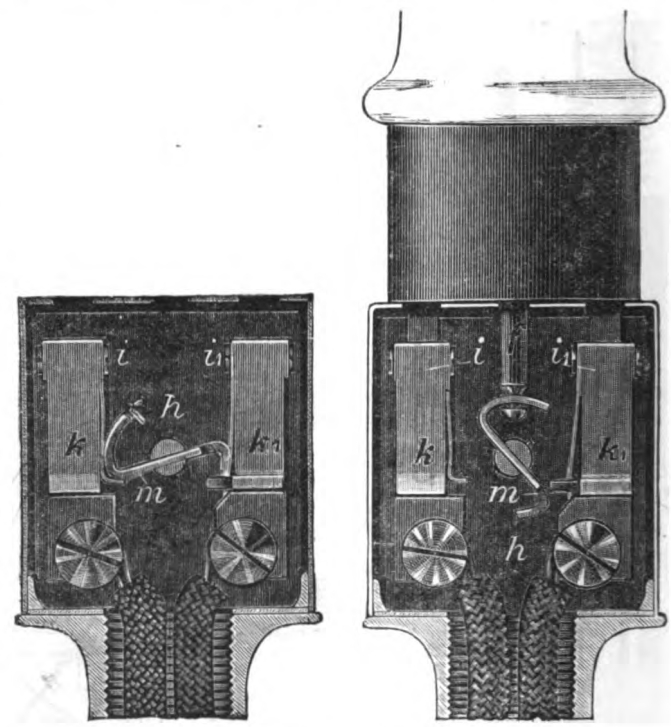
and we therefore secure an advantage which cannot be obtained in the system of constant potential. The construction of the dynamo offers no special difficulty; we have indeed to deal with the simplest conditions. The current in the field-magnets and the armature remains constant, and under these circumstances the position of the brushes on the commutator never requires any alteration. This is a very important feature of the system. In fact, the further development of the system, of which I shall speak later on, would hardly be practicable without this peculiarity of the dynamo.

If I now turn to conductors, I arrive at that part of the series system which many electricians generally consider as the only advantage of it, but I believe this Paper will show that the possibility of overcoming long distances with small conductors is only *one* of the practical advantages of the distribution of electrical energy by means of constant current. It is well understood that the expense of conductors in a series system is much below that required in a parallel system. To give an example: Supposing 100 lamps each consuming 60 watts have to be supplied with electrical energy at a certain distance from the dynamo; the lamps placed in parallel are to be each of 100 volts and .6 amperes; the lamps in series requiring 6 volts and 10 amperes. In this case the cross-section of the conductor for the parallel arrangement would have to be 36 times larger than that required to be used in the series arrangement, if the same loss of energy is to be allowed in the conductors. But, quite independent of the cross-section, we can in the latter method always maintain constant current, independent of the number of lamps in use and the distance, while the difficulty of maintaining constant potential increases materially with the distance. There is another advantage which is peculiar to the system of constant current, and this is—that there can be no over-heating of wires, and therefore safety fuses are dispensed with. The necessity of using safety fuses in order to guard against the danger of fire is one of the great drawbacks of the parallel system. Every electrician of experience has known cases in which whole groups of lamps have been extinguished by the melting of a fuse; or, what is still worse, fuses are sometimes replaced by copper wires with the idea of putting the proper fuse in place later on. In this case the danger of fire is always present. A system which can dispense with the use of fuses has certainly a considerable practical advantage.

In turning now to the lamps, I arrive at that part of the system which has caused more difficulty than any other, and which has required years of experimenting. In the manufacture of incandescent lamps, we are obliged to confine ourselves within certain limits as far as the size of the carbon is concerned. If the carbons are made for very high tension and corresponding small current, we reduce the efficiency on the life of the lamps; if, on the other hand, we use very thick carbons for strong current, the difficulty rests in the connection of these carbons with the leading-in wires and the seat of the platinum wires through the glass. Experience has shown that 10 amperes is about the maximum current for lamps in series. As the carbon in every lamp is subject to deterioration, we must provide for means to prevent interruption of the circuit by the breakage of the carbon, if the lamps are arranged in series. The first apparatus which I used for this purpose, in 1883, was actuated by means of an electro-magnet; but the size and the high price of this apparatus induced me later on to construct the chemical contact-plug. Lately, however, I have succeeded in constructing the lamp in such a way that the simplest arrangement of self-acting cut-out is placed within the lamp itself.

The construction of the lamp as now made is shown in Fig. 3; *a* is the light-giving carbon made in the form of a straight rod. The ends of this rod are attached to two nickel wires, which are soldered to the platinum wires which convey the current through the glass. The two nickel wires are bent in such a way as to almost touch each other in *c*, and one of the wires, *d*, is hammered flat so as to form a spring, which has the tendency to produce contact in *c*. This, however, is prevented by the carbon itself as long as the carbon is intact. If now the carbon becomes deteriorated by the current, it gives to the pressure of the spring, and contact is made in *c*. This simple arrangement has, moreover, the great advantage that the production of an arc inside the lamp is entirely avoided. Such an arc is often formed in lamps placed in series, if the action of the cut-out is dependent on the increase of resistance of the lamp, and the heat of the arc is very liable to crack the glass. The arrangement described above effectually prevents the arc. Constructions in which the heat of the arc is utilised for the purpose of making a cut-out, or which are based on the supposition that a high-tension current will always find its way round the lamp through a weak insulation, in case the carbon should break, can hardly be considered as practical solutions of the problem.

It is now generally acknowledged that lamps with thick carbons give a better conversion of electrical energy in light than lamps with fine carbons. Generally, we must suppose that the destruction of the carbon in the lamp in which there is a high difference of potential results from the combined action of the heat and current. Heat has the effect of diminishing the cohesion, and the electrical forces produce motion of the carbon particles from the negative to the positive pole. This process is well known in lamps of high tension, but in lamps which are required in the system of constant current, the difference of potential is so small that no destructive electrical action can take place. There is another cause which has the tendency to diminish the economy in lamps which have very thin carbons, and this is that the cooling effect of



Figs. 4 and 5.—Bernstein Incandescent Lamp Holder.

surrounding gases which may be contained in the lamp is far more perceptible here than in lamps with thick carbons. The heated carbon loses its energy in several ways, namely, by radiation, by direct convection to the surrounding gases, and by conduction of the heat to the leading-in wires which are connected to the carbon. I shall, for the present, neglect this last point. The radiation only depends on the temperature, the surface, and the quality of the carbon, but is independent of the diameter. On the other hand, convection to surrounding gases is far more marked in fine carbon than in carbons of large diameter. In a series of experiments which I have made on this point, I found that a glowing wire of ·09 mm. diameter consumes two and a-half times more energy in the atmospheric air in order to be kept at the same temperature than a wire of ·26 mm. diameter. Of course, this difference would disappear in an absolute vacuum, but as we are hardly likely to maintain a very high vacuum in the lamp, the effect is that there is practically always a considerable difference in favour of thick carbons. The nature of the surface has a great deal to do with the efficiency of the lamp, because the proportion of heat radiation to light radiation at the same temperature

Digitized by Google

materially depends on the nature of the surface. Experiments have shown that a smooth surface is highly conducive to increase the light radiation. The strong hollow carbons which are used in glow lamps for series lighting have made it possible to obtain in them a very smooth surface by using a mechanical process of polishing the carbon; such a process is, of course, not applicable in the fine twisted carbons used in lamps of high resistance. For the purpose of supplying light from central stations, the peculiarity that lamps for strong currents give a much higher effect than can be obtained from lamps of high tension and small current is, of course, of the greatest importance, as this results in materially reducing the price of electric light. There is another point in favour of the straight thick carbon rod, as compared to the fine twisted thread, which merits consideration. These latter produce a disagreeable irritation of the eye, whenever we look from the heated carbon into the dark, when the impression of the bright thread is retained on the eye. This is not the case with a straight carbon rod; and in all places in which both kinds of lamps have been in use, I have been assured that the straight carbon rod is much preferred as a light-giving body, especially by persons with sensitive eyes.

The construction of the lamp requires the application of a specially-constructed holder, which is illustrated in Figs. 4 and 5. Two metal sleeves, into which the square terminals *b b* of the lamp are made to fit, are attached to an insulating plate, *h*. The outward part of these sleeves is replaced by the springs R R_1, which insure good contact by pressure of the terminals against the metal sleeves. A piece, *m*, in the form of an S, can be turned by a handle. In the position of this piece, shown in Fig. 4, the current is short-circuited inside the holder. The flat spring K_1 carries a small steel pin, which in the position shown prevents the piece *m* from being turned, so that the circuit cannot be opened. If, now, the lamp is placed in the holder, the spring K_1 is slightly lifted, in such a way that the pin is now outside of the level of *m*. This piece can now be brought into the position shown in Fig. 5, when the lamp will be alight. However, as long as this is the case, the lamp cannot be removed from the holder on account of the piece *f*, which is fastened to the lamp cap, and which is now held in place by *m*. If it is desired to remove the lamp from the holder, the current must first be short-circuited in the holder by turning *m* again into the position shown in Fig. 4. It is therefore clear that any interruption of the circuit is effectually prevented. If I now add that if every circuit is provided with an ammeter, and that switches of well-known construction are used for extinguishing groups of lamps, I have fully described a simple series circuit.

(To be continued.)

UNDERGROUND CONDUCTORS.

BY DAVID BROOKS.

Conduits for underground electrical conductors are generally supposed to facilitate the construction and repairs of an underground system; but, in my opinion, such is not the case, as I will endeavour to show. Nothing that is drawn in can long withstand the damp and confined atmosphere of a conduit, mixed as it is with sewer and illuminating gases. If the conduits are made of wood, the acid coming from the wood itself contributes to the process of disintegration and decay. When a cable or conductor in a conduit fails, in nine cases out of ten there are no cables or conductors ready to supply the place of the one pulled out, and it is necessary to wait for one to be manufactured. This is the "draw in and draw out" system.

The Edison system is different. The faulty conductor cannot be pulled out and replaced by another; but the fault, when it occurs, is local, and can be located to an inch, and remedied in as short or less time than it takes to get ready to pull a cable of 500 feet in length out of a conduit. The Edison Company in Philadelphia have located and removed or repaired over 300 faults, due to original bad construction rather than to the system itself. The locating of faults with such exactitude is effected by the "loop-test." Faults in ocean cables are located by this means within a few miles. In ordinary city limits they are located within a few feet. When it comes to the distances between splice-boxes or hand-holes, the defect can be located to an inch.

The system with which I am identified is a draw in but not a draw out system, for the reason that there has been no occasion to draw out. If the insulation is impaired or destroyed, it must be from mechanical means, such as breaking or injuring the wrought-iron pipe, which is proof against an accidental blow of the picks. The pipe is placed so far below the surface of the ground as not to be disturbed in ordinary street repairs. The material within the pipe is hermetically sealed from such agencies as destroy gutta percha, indiarubber, or anything else that is of the vegetable kingdom. The oil we use in the pipe is a pure distillate, and no product of distillation undergoes change, except for the better, when confined in air-tight vessels. Thus there is no deleterious change. As before stated, the Brooks method is not a draw out system, for the reason that there is no necessity to draw out. But a thousand feet of cable can be drawn out easier than five hundred feet could be drawn from any conduit system, because the former is lubricated inside the pipe. If perchance the insulation becomes impaired, as stated, it must be from some damage done to the pipe serious enough to expose the conductors, as a mere hole in the pipe will not admit moisture, because the oil is much heavier than water. The defect must be local, and its position can be readily determined, as before explained. A pipe-cutter, with a few feet of cotton-covered wire, can easily repair the damage. On the other hand, when a fault is detected in a cable that has been drawn into a conduit, every portion of it shows serious disintegration. If a cable on my system is injured by mechanical means, the surface of the ground must be disturbed, which would be enough to indicate the exact position of the fault, without the aid of the loop-test.

The effect of confined air, such as is contained in a conduit, has been known in England for at least thirty years. A patent was taken out to preserve the gutta-percha covering on conductors by drawing the cables into iron pipes filled with water. The English Post Office department do this yet wherever it is practicable.

Telephone exchanges require large numbers of conductors of small diameter. Five hundred of these conductors properly insulated can be drawn into a three-inch pipe, when oil is used. These conductors generally take one direction in getting from the basement of the exchange into the street. Suppose for that purpose a single pipe of large diameter is used: for instance, one of 15in., the ends of the pipe being bent upwards in order to prevent the loss of oil—this pipe would have a capacity for ten thousand conductors, which could be drawn into the oil in groups of one hundred. I know of no method by which the insulation could be so well preserved. Now compare the cost of such an arrangement with the conduit system. Ten times as much money is spent in making a poor job as is necessary to make a good one. When once in the street, the conductors would diverge and take opposite directions. Then two or more pipes of smaller dimensions could be used. Such a plan could be adopted as would accommodate the number of wires as they diverge in different directions. Again, compare the cost of such an arrangement with that of some of the subways that have been constructed in New York City. Philadelphia has more electrical conduits than all the other cities of the United States. There are as many as four in some of the streets. There are, however, very few conductors in them, but a new industry has been developed: that of keeping the subways in repair—pumping water from the man-holes, cleaning them from the dregs of the sewers that have been broken open, and their contents deposited in the ducts. In some cases the water mains have broken and filled the conduits with water, producing washouts and caving in of street pavements. Rotating fans are used to clear the conduits of the explosive gases, which also produce death by suffocation, nearly as instantaneous as that produced by the arc light currents in New York City. We have had over 50 explosions in Philadelphia. I have this on the authority of one of our best-posted electric light engineers. Most of our conduits are made of wood, and the explosions, as a consequence, do not reach the magnitude of

Digitized by Google

some that have occurred in Broadway, New York, where, according to the reports in the New York papers, a cast-iron man-hole cover, weighing 300lb., was thrown over a four-story building. The ducts of these conduits are made of wrought iron. Conduits are expensive, and their construction a slow process, which interferes with the use of the streets. Large quantities of earth have to be carted away. With the Brooks system, the iron pipe occupies so small a space that all the earth taken out is repacked in the trench. Ten thousand feet of trench have been opened, the pipe laid, the trench closed, repaired, and cables drawn in, between seven in the morning and six o'clock in the afternoon of the same day, and no patching or levelling up of pavement required afterwards. It is stated that in laying conduits extra ducts can be provided for future growth of business. By the Brooks system extra conductors, or a cable containing more conductors than required by the present need, can be drawn in by the one operation. By the Brooks' system there are no vacant spaces for the collection of explosive and deleterious gases.

In proof of what I say, it goes for something that the cable I laid for the Pennsylvania Railroad Company, containing 53 conductors, has worked for nearly three years without a moment's interruption to any of the conductors, although connected to overhead wires running to New York, Pittsburgh, and Washington. There has been no expense for repairs and maintenance except to paint those portions of the pipe running over a bridge and along an elevated railway.

THE BIRMINGHAM EXHIBITION.

We this week conclude our notices of the Birmingham Exhibition with descriptions of the exhibits of Messrs. Immisch and Co., the Electric Construction Corporation, Messrs. Appleby, Burbey, and Williamson, Messrs. Crossley Brothers, and the Campbell Gas Engine Company.

Immisch and Co.—Messrs. Immisch exhibited a number of motors and dynamos of the types for which the firm have become famous. A 2-horse mining-type motor was made to drive a ½-horse dynamo, which supplied current to a 2-horse motor running light. The mining-type motor was of the same type as the larger machine which has been in operation at St. John's Colliery, Normanton, since February, 1888, and which has been running about 22 hours per day up to the present time. The next object of interest was a tramcar motor, similar to those fitted to the cars on the Barking and Canning Town tramways. The motor was of the type in which the armature rotates between two vertical field-magnets, which are joined at both ends by castings forming the pole-pieces; it is designed to develope 10 horse-power when running at 1,000 revolutions, and requires a current of 68 amperes at 160 volts E.M.F. The motor exhibited was fitted with an ordinary pulley, but when employed for car driving this is replaced by a spocket wheel for chain gearing. A constant-current series motor of the vertical magnet type, to develope 3½ horse-power, was also exhibited. In this machine the regulation was effected by means of a very compact centrifugal governor, which was fitted on the end of the shaft. The centrifugal arrangement operates a sliding connecting bridge, which makes the connection between the two field-magnet windings. The coils of the magnets are wound in a number of sections, and connection is made at a point between each section to a number of insulated plates, the plates connected with corresponding parts of the magnet coils being opposite each other. The sliding bridge, in making connection between a pair of these plates, short circuits an equal number of sections on each magnet limb, and the number of ampere turns is thus varied in conformity with the variation of load or E.M.F., as the case may be. Messrs. Immisch also supplied the motors to some of the exhibitors who were using power on their stands.

The Electric Construction Corporation (Limited).—This company exhibited a battery of 27 of their B 31 type storage cells, which were employed to light the dining rooms. The total capacity of the cells, as given by the makers, was 700 ampere-hours. During the Exhibition the daily requirement amounted to 329 ampere-hours per day, with a maximum rate of discharge of 87 amperes, which occurred regularly for one and a-quarter hours per day. The charging current was 60 amperes, and was maintained for six hours each day, or a total of 360 ampere-hours' charge. This shows a *current* efficiency of 91½ per cent. The condition of the battery appeared to be perfect in every respect. This company also exhibited a burglar alarm, adapted for houses having a 50-volt circuit at command, but which can, of course, be arranged to work with current from any source of sufficient power. The point of interest about this alarm is the arrangement by which a reciprocating motion is obtained. A glance at Fig. 1 will explain this. *a* is an iron core, which is fitted at each end with a lengthening piece of brass, which carries a small steel striker fixed in its end: the striker strikes the bell (indicated by dotted lines) at opposite points in alternation; *b b* are two coils, of

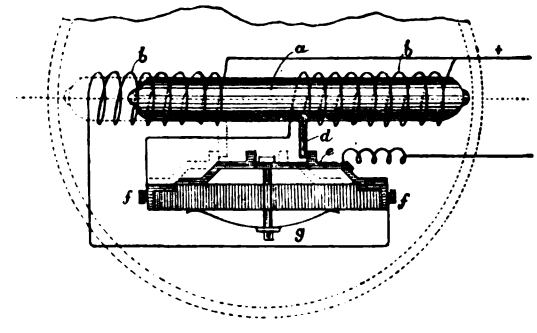


Fig. 1.—Burglar Alarm for House with a 50 volt circuit.

which one end of each is connected permanently to one pole of the exciting circuit, and the other two ends are connected to insulated plates, *f f*. The iron core carries a projecting pin, *d*, which engages towards the end of each stroke with one or other of the projecting lugs on the sliding connector *e*. The other pole of the exciting source is connected by a flexible lead to the sliding connector. When the core is pulled up to one end by the action of the current in one coil, the sliding connector cuts off connection with this coil and makes connection with the other, and a reciprocating motion is the result. In the alarm exhibited the coils *b b* have a resistance of about 60 ohms.

Appleton, Burbey, and Williamson.—This firm exhibited their patent adjustable switches, an illustration of which we give below (Fig. 2), also a very simple and well-designed

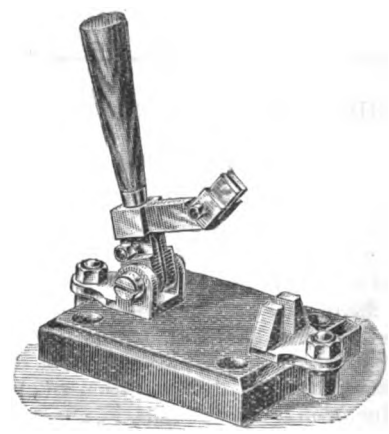


Fig. 2.—Adjustable Switch.

automatic switch for use with accumulators (Fig. 3). When the battery is not being charged, the balance lever is held down by the weight at the end, and the circuit through the coil is completed by means of the mercury contact. The coil is a shunt on the dynamo terminals, and the weight on the lever is so adjusted that the iron core which hangs in the coil shall be attracted with sufficient force to lift it when the E.M.F. is sufficiently high for the battery to be connected on

Digitized by Google

for charging. When the lever lifts up, the charging circuit is completed by means of the mercury contacts on the other end of the lever, and the shunt-circuit is broken. An electro-magnet whose coil is in the charging circuit comes into action when the circuit is completed, and maintains the connection so long as the charging current does not fall below a minimum value. If this occurs, the charging circuit is broken and the shunt circuit re-made, and the contrivance is ready to switch the battery on as soon as the E.M.F. has again reached the required value for charging.

This firm also exhibited teak boxes for accumulators, which were made acid proof by means of a thin liner of celluloid material.

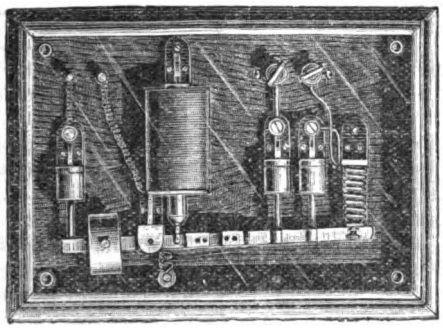


Fig. 3.—Automatic Switch for use with Accumulators.

Crossley Brothers.—This firm exhibited their newest form of gas engine suitable for running electric light installations; a 3 horse-power vertical engine, speeded up to 250 revolutions, was driving an Elwell-Parker dynamo, from which the stand was lighted by means of fifty 16 candle-power lamps. A 4 horse-power horizontal engine also drove an Elwell-Parker dynamo, which was employed to charge the battery of 31 B type cells, from which the dining rooms were lighted. These engines were fitted with the tube ignition and Messrs. Crossley's new timing valve. With a tube ignition in its simplest form there is a possibility of the charge being ignited before or after the proper time; the timing valve is designed to obviate this danger. Fig. 4 represents a section through the timing

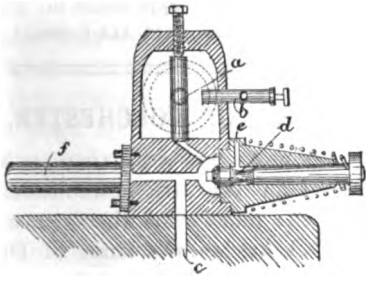


Fig. 4.—Section of Timing Valve fitted to the Otto Gas Engine.

valve of a vertical engine: *a* is the end view of the ignition tube which stands up perpendicular to the paper in the drawing, *b* is the Bunsen burner which maintains the tube at a red heat, *d* is the valve, *e* is a small opening to the outside air, *f* is a small closed chamber in connection with the gas ways, *c* is the passage which leads iuto the cylinder. The valve is shown in the position which it occupies at the moment when the charge is to be ignited. The compressed charge enters from the cylinder by the pasage *c*, fills the small chamber *f*, and passes through the passages into the ignition tube and is ignited. A cam now presses the valve *d* inwards (against the spiral spring), the point of the valve closes the passage into the cylinder, while the gas and air in the chamber *f* insure the maintenance of the flame and the proper ignition of the charge; at the same time the valve *d*, having a clearance cut on the parallel part just below the valve, connects the small outlet *e* with the ignition tube, and thus gives it an independent exhaust. These combined arrangements make the ignition of the charge at the proper instant an absolute certainty. The ignition tubes of these engines require renewal about every five or six days, as they become oxidised right through and choked completely with gas carbon in this short time. The cost of the tubes is trifling, and they are readily replaced.

The "Campbell" Gas Engine Company (Limited).—This company exhibited a 4 horse-power engine, which drove a dynamo, from which the stand was lighted by means of 16 candle-power lamps. This engine has an impulse every revolution, which is secured by the employment of a pump in addition to the working cylinder. There are very few valves about this engine, and its cycle of actions is extremely simple, and is as follows:—The pump piston on the out-stroke takes in a charge of air and gas, and on the return stroke compresses it; in the same time the working piston has reached the limit of its out stroke, and the exhaust ports—which are in the sides of the cylinder at the front end—being uncovered by the piston, the exhaust gases escape; when the pressure in the working cylinder is thus removed, the new charge which is compressed in the pump cylinder opens a valve, and passes into the working cylinder. The working piston now returns and compresses the charge, a portion of the mixture reaches the red-hot part of the ignition tube, and the impulse takes place. The engine is fitted with a very simple governor.

Messrs. Barker exhibited two gas engines, one with their patent rotary valve, which was so highly spoken of by Prof. Smith in his report of this engine, and the other with a tube ignition. The engine with tube ignition drove a Stafford and Eaves dynamo.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To night) FRIDAY, November 29th.

Institution of Civil Engineers.

7:30 p.m. Students' Meeting. Paper to be read, "Principles of Iron Foundry Practice." By G. H. Sheffield, Stud.Inst.C.E.

Electro-Harmonic Society.

8 p.m. Concert at St. James's Hall Restaurant, Regent Street. (Ladies' night.)

MONDAY, December 2nd.

Royal Institution.

5 p.m. General Monthly Meeting.

London Institution.

5 p.m. Lecture: "The Growth of Crystals in Rocks." By Prof. J. W. Judd, F.R.S.

Society of Engineers.

7:30 p.m. Ordinary Meeting. Paper to be read, "Fox's System of Solid Pressed Steel Waggon Frames." By Perry F. Nursey, Past President.

Society of Arts.

8 p.m. Cantor Lecture I. 2. "Modern Developments of Bread-Making." By William Jago.

TUESDAY, December 3rd.

Institution of Civil Engineers.

8 p.m. Ordinary Meeting. Paper to be further discussed, "Water-Tube Steam Boilers for Marine Engines." By Mr. John J. Thornycroft, M.Inst.C.E. Paper to be read, time permitting, "On the Triple-Expansion Engines at the Owen's College, Manchester."

Royal Victoria Hall.

8:30 p.m. Lecture: "Snakes and Snake Poison." By Dr. W D. Halliburton, M.R.C.P.

WEDNESDAY, December 4th.

Civil and Mechanical Engineers' Society.

7 p.m. Meeting at the Westminster Palace Hotel. Opening Address by the President, Henry Adams, M.I.C.E.

Society of Arts.

8 p.m. Ordinary Meeting. "Rabies and its Prevention." By Armand Ruffer, M.A.

THURSDAY, December 5th.

London Institution.

6 p.m. Lecture: "Recent Work on Moulds and Mildews." By Henry Power, M.B.

Digitized by Google

The Electrician.

ublished every Friday. Price Fourpence; Post Free, Fourpence Halfpenny.
Editorial, Publishing and Printing Offices:

No. 1, SALISBURY COURT, FLEET STREET, LONDON, E.C.

Telephone No. 2714. Telegrams: "ELECTRICIAN NEWSPAPER, LONDON."

All Communications to be addressed to "THE ELECTRICIAN," *1, Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN."

All letters intended for insertion in "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. Subscribers should receive their copies by the first post on Friday morning.*

"THE ELECTRICIAN" *is on sale at the railway bookstalls throughout the United Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices as above.*

SPECIAL NOTICE.

Owing to the increase in the number of pages of "THE ELECTRICIAN," in order to partly cover the increased postage, we have been compelled to revise the rates for Foreign Subscriptions, which are now as follows:—

	3 months.	6 months.	12 months
For Foreign Parts and Colonies:—	s. d.	s. d.	s. d.
Within Postal Union	6 6	12 6	24 0
Aden, Borneo, Ceylon, China, India, Japan, Java, Labuan, Mozambique, New Caledonia, Persia, Philippine Islands, Siam, Transvaal, and Zanzibar	7 6	14 6	28 0
The rates for the United Kingdom remain as follows:—	5 0	10 0	19 6

TO ADVERTISERS.

"THE ELECTRICIAN" *offers exceptional advantages to Advertisers.* **It has the largest circulation of any English Electrical paper, and circulates all over the World.**

Particulars relating to Advertisements will be promptly forwarded on application to the office.

TRADE ADVERTISEMENTS *intended for the current issue must be handed in not later than First Post on Thursday morning.*

SMALL PREPAID ADVERTISEMENTS *(for Rates see page xiii.) are accepted up to 4:30 p.m. on Thursday.*

TECHNICAL PRINTING.

"THE ELECTRICIAN" PRINTING AND PUBLISHING COMPANY (LIMITED) *beg to inform Electricians, Electric Light Engineers, &c., that they make a specialty of Technical Printing, and have a Staff thoroughly acquainted with Electro-Technology. They can, therefore, promise Accuracy and Despatch in the Printing of Electrical Catalogues and Electro-Technical Literature generally.*

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.

Royal 8vo.

Early in each year is issued "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK. *The* DIRECTORY *was established in 1883, and the 1889 Edition, which is now on sale, consists of more than 600 pages of printed matter. Every care is taken to make the names and addresses of all persons engaged in the Electrical Industries absolutely accurate. Useful Tables and Electrical Formulæ are given, together with popularly-written Biographical Notices of the leading Electricians, Electrical Engineers, &c., accompanied in many cases by Portraits.*

The issue for 1890, which will be still further enlarged and improved, is in active preparation. New Names and Addresses, Corrections, Advertisements, &c., should be forwarded at once to the Publishing Office, **1,** *Salisbury-court, Fleet-street, London, E.C.*

CONTENTS OF THE CURRENT NUMBER.

NOTES 79
On the Distribution of Electric Energy by Means of Constant Current. By Alexander Bernstein. Illustrated 84
Underground Conductors. By David Brooks 87
The Birmingham Exhibition. Illustrated 88
Meetings of Scientific Societies... 89
GILBERT, OF COLCHESTER 90
Sir William Thomson's Chain of Electrostatic Voltmeters. By Andrew W. Meikle, M.A. Concluded 91
The Institution of Electrical Engineers—
"The Lighting of the Centennial International Exhibition, Melbourne, 1888 and 1889." By K. L. Murray, C.E. Illus. Continued ... 92
The Wheless Electric Railway System. Illustrated 96
London Chamber of Commerce. The Electrical Trades' Section and the Birmingham Exhibition 96
Physical Society—
"The Effect of Repeated Heating and Cooling on the Electric Resistance of Iron." Illustrated 97
The London County Council and Overhead Wires 98
American Notes 98
Paris Notes 99
CORRESPONDENCE—
Single-Magnet Dynamos.—W. B. Esson. Illustrated.. 99
The Institution of Electrical Engineers.—"Electric Light" 100
LEGAL INTELLIGENCE—
R. S. Blackburn *v.* Smith and Co. 100
The Kent Arc Lamp. Illus.... 100
Trade Notes and Notices 101
PATENT RECORD 102
COMPANIES' MEETINGS, &c.—
The Brush Electrical Engineering Company (Ltd.). 102
New Companies Registered ... 103
City Notes, &c. 103
Companies' Share List 104

"THE ELECTRICAL WORLD" OF NEW YORK.

Arrangements have been made by which "THE ELECTRICAL WORLD" OF NEW YORK *can be obtained from* "THE ELECTRICIAN" *Office, 1, Salisbury-court, Fleet-street, London, E.C.*

The Rate of Subscription (payable in advance), is **£1 1s. 0d.** *per annum.*

Single Copies of "THE ELECTRICAL WORLD" *can also be obtained,* **price 6d. each; post free, 8d.**

"THE ELECTRICIAN" *can also be obtained of the* W. J. JOHNSTON COMPANY (LIMITED), "THE ELECTRICAL WORLD" *Office, Times Building, New York, U.S.A.*

Subscriptions are received by "*The Electrician*" *Printing and Publishing Company for all Continental and American Electrical Journals. Subscription Rates on application to* "THE PUBLISHER." *Remittance must accompany order* IN ALL CASES.

GILBERT, OF COLCHESTER.

Just as we go to press this week there is being held the inaugural meeting of an Association established to do honour to the memory of the founder of the science of electricity. Although to every electrician the name of Dr. GILBERT, of Colchester, is more or less familiar, the outside public is strangely ignorant both of the man and of his claims to a niche in the roll of the worthies who have made England famous. What SHAKESPEARE is to the drama, what RALEIGH is to geography, what SPENSER is to poetry, what BACON is to philosophy, that, and more than that, is GILBERT to the science of electricity. Born at Colchester in 1540, and educated at St. John's College, Cambridge, of which he was a Fellow, he embraced the profession of medicine, travelling much abroad in the prosecution of his studies. Great distinction awaited him, and he rose to the summit of his profession, becoming in 1599 President of the Royal College of Physicians. He had for some years been physician in ordinary to Queen ELIZABETH, and at her decease in 1603 was continued as physician to JAMES I., an honour cut short by GILBERT'S death in November the same year. His fame, which even before this extended throughout Europe, was based, however, not upon his medical distinctions, but upon his experimental studies in magnetism. Living alone, and possessed of adequate means, he expended, as is recorded, no

Digitized by Google

less a sum than five thousand pounds upon his researches, and amassed a fine collection of loadstones and magnetic apparatus, globes, charts, instruments, books, and manuscripts. Even before he had published a single line of his researches, the fame of them had gone abroad through the scientific men in the various universities of Europe. At length, in 1600, appeared his famous book, "De Magnete," a fine folio volume of two hundred and forty pages, the Latin text printed in bold Dutch type by PETER SHORT, of St. Paul's Churchyard, and illustrated with numerous primitive woodcuts of his apparatus and experiments. The book was of a sort wholly novel and strange, even to the learned men of that time. Men still lived in the shadow of mediæval modes of thought, and were accustomed to have all scientific facts wrapped up in a portentous metaphysical jargon, in the manner of the disputations of ST. THOMAS AQUINAS, and embroidered with a fringe of magic and mystery, teeming over with erudition and speculative philosophy. To men steeped in such literature it was quite incomprehensible that valuable scientific facts should be discovered by the simple device of actually trying experiments; quite inconceivable that any one with the reputation of being a philosopher should set them down in plain unvarnished fashion, without attempting to explain them by occult disquisitions showing their relation to the mysteries of the universe. And, that such an individual should have propounded the insane notion that the earth itself was a great magnet, in order to explain why compass needles pointed northwards—why, was it not known that the great PARACELSUS had reported that the compass pointed northwards by reason of the virtue proceeding forth from the stars in the constellation of the Great Bear? And had not the immortal CARDANUS located that virtue in the particular star at the tip of the Great Bear's tail? And, if that was not explanation enough, had not MAUROLYCUS discovered in the great North Sea a magnetic island which would even draw the iron nails out of the passing ships, and was not its position set down in the charts of PLANCIUS? Why then should they listen to the new doctrine that the earth was itself a magnet, on the mere suggestion of a man whose philosophy began and ended with experiments made on little loadstones? Nay, worse than this, it was unendurable that the man who had so abused his position as a philosopher as to condescend to a purely experimental method should turn round and poke fun at the philosophers for their stupid magic and their senseless mystery, and curse them for darkening knowledge with words.

Accordingly we find that the appearance of "De Magnete," though it won the admiration of GALILEO, and secured the enthusiastic adhesion of KEPLER to the new doctrine of the magnetism of the earth, was derided by the wordy philosophers of the day, such as SCALIGER, and even by BACON, whose claim to be regarded as father of the experimental method is based on writings of fifteen years' later date.

To us, as electricians, however, the main interest in Dr. GILBERT centres around a single short chapter in "De Magnete," where he steps aside for a moment from the immediate subject of the magnet to discuss the attraction excited by amber that has been rubbed. This fact, discovered at least 500 years before the Christian era, had remained an isolated fact, save only for the knowledge that jet shared a similar property. Concerning amber, as concerning the loadstone, there had grown up a luxuriant crop of fabulous mysteries. These, too, went down by a touch when the master-hand of GILBERT applied the test of the experimental method, and showed that not alone amber but a vast class of bodies, which he termed electrics, including the diamond and other gems, paste gems, glass, shellac, resin, mastic, and the like, possessed similar powers of attracting. To test their power he devised a simple electroscope. He discovered the adverse influence of moisture, and the screening action of an interposed sheet of metal. Not without some blunders, he pushed his way into the region of the unknown, and stopped short all too soon. Not too soon, however, to make good his enduring claim to the distinction of being the first electrician; the spiritual father of the Guerickes, the Boyles, the Hauksbees, the Stephen Grays, and the Franklins who followed along the path he had trodden alone. Nor do his claims on posterity end here, for he founded a "college," or society, which used to meet periodically at his house in Peter's-hill, Knightrider-street, to discuss philosophical subjects, of which "college" the Royal Society is the legitimate successor. That he has been so little honoured with the wider fame that attaches to his great contemporaries is due doubtless to the circumstance which has robbed us of his own precious and priceless mementos. His collection of magnets, instruments, charts, and manuscripts, the outcome of a life of ceaseless activity, he bequeathed to the Royal College of Physicians, who preserved it with all due care only to perish when their building was destroyed in the Great Fire of 1666. His house at Colchester still stands, his tomb in the church of Holy Trinity in that city still attests his virtues, and his memory is kept green at Cambridge by the Johnians, who claim him as one of the honoured worthies of their college. But his true monument, a monument "more enduring than brass," survives in the treatise which he bequeathed to mankind. It is this treatise which the newly-founded Gilbert Club proposes to reproduce, Englished in its phrase, but preserving with scrupulous fidelity all the peculiarities of the original, even down to the grain of the paper and style of the binding. The greatest electrician of the nineteenth century has been by common consent named President of the Club, and the rush for membership in it is a proof at once of the worthiness of the object and the fitness of the mode of action which has been chosen. The re-publication of "De Magnete" by English electricians is a fitting mode of commemorating the worth of this great Englishman.

SIR WILLIAM THOMSON'S CHAIN OF ELECTROSTATIC VOLTMETERS.

BY ANDREW W. MEIKLE, M.A.

(*Concluded from page 60.*)

The range of electrostatic measurement for ordinary practical purposes by the chain of instruments described above is complete from 25 to 50,000 volts; but, though little difficulty would be found in making an instrument, were it desired, to suit higher ranges, the problem of finding a convenient electrostatic instrument to give direct readings of potential below 50 volts is more difficult. No doubt a voltmeter of the Multicellular type could be made with a lower range, but in order to do so the length of the suspending wire, or the mass of the movable part, would require to be increased to such an extent as to render the instrument very cumbrous, and at the same time difficult to observe on account of the long period of vibration which its indicator would have. For laboratory and accurate scientific work a means of extending the range downwards is provided in the Quadrant Electrometer, which can be used when adjusted to best advantage to measure from $\frac{1}{100}$ to 40 or 50 volts. In the practical working of alternating installations it is seldom necessary to measure potentials so low as 50 volts, but for use with direct currents Sir William Thomson has invented a Magneto-static Voltmeter which gives direct readings from a small fraction of a volt up to 200 volts, and is found convenient for work with storage batteries and for other purposes. A description of this instrument will be given in a subsequent article.

Digitized by Google

THE INSTITUTION OF ELECTRICAL ENGINEERS.

"The Lighting of the Centennial International Exhibition, Melbourne, 1888 and 1889."*

BY K. L. MURRAY, C.E.

(Continued from page 69.)

The curves in the diagram (Fig. 3) were taken to ascertain the relative value of the magnetic circuits in the two classes of frames. The method adopted was as follows :—The commutator brush-holders were electrically disconnected from the field-magnet circuit. The ordinary brushes were taken out and replaced by others so bent that contact could be made with the commutator at the neutral point. The armature was run at the normal speed, and the field-magnets were separately excited by a variable current taken from an incandescent circuit. Simultaneous readings were taken of the current through the field coils, the potential difference at the terminals of the armature, and the speed of rotation. From these data curves were plotted as shown in the diagram. All the machines tested in this manner had similar thin-plate armatures. The resistance of the voltmeter used was great, so that the potential difference as shown by it was practically the electromotive force of the machine. As the number of windings and speed of rotation of the armatures were the same, the electromotive forces would be directly proportional to the total induction through the armatures. The induction through the armatures depends on the magnetising force (H) of the current in the field coils, and the goodness of the magnetic circuit. In the machines tested, the number of windings on the field coils were equal. Hence the electromotive forces of the different machines, when taken with the same current in the field, will

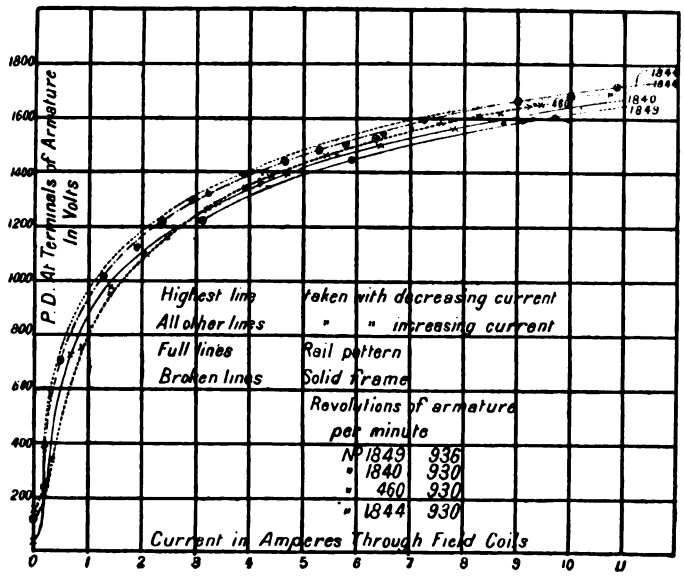

P.D. At Terminals of Armature In Volts
Highest line taken with decreasing current
All other lines " " increasing current
Full lines Rail pattern
Broken lines Solid Frame
Revolutions of armature per minute
№ 1849 936
" 1840 930
" 460 930
" 1844 930
Current in Amperes Through Field Coils

FIG. 3.

represent the relative values of their magnetic circuits. The curves may be taken either as saturation curves of the total magnetic circuit, or as curves of total induction through the armature, provided no sensible current is taken from it.

An examination of the curves in Fig. 3 will show a small magnetic advantage in favour of the solid frames. This result was expected, from the fact that the bed-plate increases the effective cross area of the field-magnet yokes, but is not likely to materially increase the magnetic leakage owing to the great length of circuit. The early part of curve of dynamo No. 460 was taken with the very greatest care. Only a few of the points are marked, for clearness, as the curve passed evenly through them all. The usual concavity at the commencement is shown in a marked degree. The slow rise of this curve for low degrees of excitation seems to indicate a greater degree of hardness of the iron. All the curves approximate to the same form over that portion of their length which corresponds with the ordinary range of excitation.

Table B shows the conditions of running and general behaviour of the machine shortly after starting. Very little more time was allowed before the measurements were taken than was necessary for the lamps to assume a proper working condition. At times, however, the tests had to be postponed till the machinery attained its normal speed. It will be seen that the current in most cases was above 10 amperes.

In Table C the more important values given in Tables A and B are compared, and their differences, with their proper signs, are added, to enable the alterations which take place when the machines and lamps are heated, to be more readily detected.

The current, in every case but one, fell as the evening advanced. This reduction is mainly due to the increase in resistance (due to heat) of the shunt circuit in the lamps. The effect of this is to lessen the action of the fine wire in the differential coils and allow the carbons to be separated a little farther ; that is, to increase the potential difference required at the terminals of the lamps. In ten out of twelve of the arc machines tested, the commercial efficiency was found to increase with the reduction of current that took place from the above cause. In the other two machines the current and efficiency rose or fell together. A comparatively small increase of current above the normal is found to produce a sensible diminution in the efficiency. Hence in practical work it is important to ascertain the most efficient current to take from the machines, and see that it is always maintained at that value. The increase in the efficiency may be partially due to a reduction in the losses caused by Foucault currents in the armature and field-magnets, brought about by an increase in the specific resistance of the metal by heat. The loss due to magnetic viscosity in the armature core may also be lessened by the same agency. It will be seen that the average output of the machines is much about the same whether they are hot or cold.

Total output of 12 machines, cold	199·42	electrical horse-power.
" " hot	195·94	" "
Difference.....	3·48	" "
Total power absorbed at pulleys by 12 machines, cold	279·77	horse-power.
" " " hot	261·11	"
Difference	18·66	"

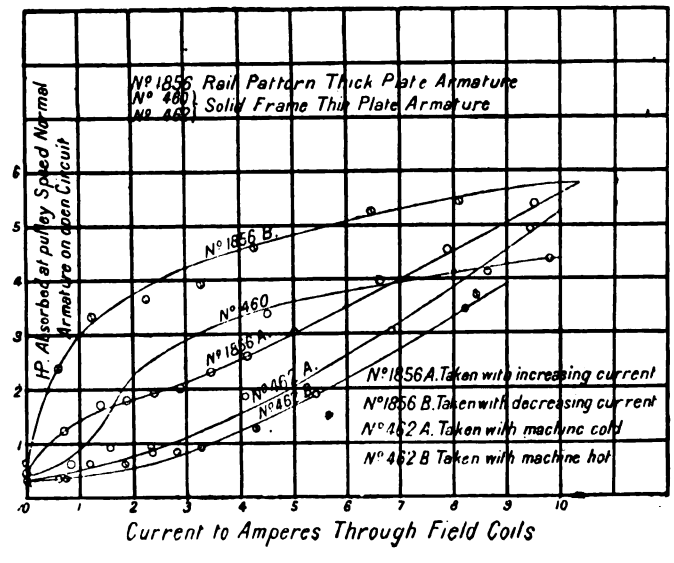

№ 1856 Rail Pattern Thick Plate Armature
№ 460 } Solid Frame Thin Plate Armature
№ 462
H.P. Absorbed at pulley Speed Normal Armature on open Circuit
№ 1856 B.
№ 460
№ 1856 A.
№ 462 A.
№ 462 B.
№ 1856 A. Taken with increasing current
№ 1856 B. Taken with decreasing current
№ 462 A. Taken with machine cold
№ 462 B. Taken with machine hot
Current to Amperes Through Field Coils

FIG. 4.

The power absorbed by the machines is much less when they are hot—the total reduction in the twelve tested being 18 66, or 1·5 horse-power per machine, while the diminution in the output was little more than a quarter horse-power per machine. This fact accounts in some measure for the gradual increase in the speed of the engines (which has been previously mentioned) as the evening advanced, though the steam pressure and number of machines driven remained constant.

As there is no direct method of ascertaining the power absorbed by Foucault currents and magnetic viscosity while the machines are at work (the usual method being to find the value of all directly measureable quantities and subtract their sum from the total power absorbed by the machine, the balance being debited to the above causes), an attempt was made to find approximately the alteration in the magnitude of these losses corresponding with given variations in the total induction through the armature, by the following method :—The dynamometer pulley was placed on the machine to be tested, the field-magnets were arranged so that they could be separately excited by a variable current, and the commutator brushes were removed from the machine. The zero of the pulley was noted, and the machine then run at the normal speed, the deflection produced on the pulley indicating the power absorbed by mechanical friction. The field-magnets were then gradually excited and simultaneous deflections on the amperemeter and pulley

* Paper read before the Institution of Electrical Engineers, November 14 1889.

Digitized by Google

TABLE B.—EFFICIENCY OF BRUSH ARC DYNAMOS (No. 7L) COLD.

Description of Machine.		Maker's Number. Machine.	Maker's Number. Armature.	Mechanical Data. Time of Run.	Mechanical Data. Revolutions per Minute.	Mechanical Data. H.-P. absorbed at Pulley.	Electrical Data. Current in amperes.	Electrical Data. At Terminals. P.D. in volts.	Electrical Data. At Terminals. E.H.P.	Commercial Efficiency.	Commercial Efficiency. Mean.
				Hr. Min.						%	%
Solid Frame.—Armature Plates ...	Thin.	457	N.T.A. 149	0 37	930	18·59	9·745	1,132·6	14·79	79·6	
		924	N.T.A. 146	0 30	913	22·24	10·495	1,251·9	17·32	77·8	
		454	N.T.A. 143	0 10	920	22·74	10·127	1,204·2	16·34	71·85	74·29
		460	157	0 30	930	22·47	9·3	1,295·3	16·14	71·82	
		462	...	0 12	930	24·57	10·313	1,251	17·29	70·37	
	Thick.	467	N.T.A. 184	0 15	930	25·8	10·423	1,232	17·22	66·74	66·74
Rail Pattern.—Armature Plates ...	Thin.	1846	158	0 10	908	24·22	10·423	1,263·6	17·6	72·8	
		1840	152	0 27	914	22·26	10·202	1,168·4	15·97	71·7	71·43
		1849	161	0 25	934	25·59	10·239	1,303·2	17·88	69·8	
	Thick.	1843	N.T.A. 168	0 35	927	23·82	10·239	1,231·9	16·91	70·99	
		1861	172	0 35	920	20·51	9·428	1,036·7	13·10	63·87	68·27
		1856	167	0 28	917	26·96	10·495	1,341	18·86	69·95	

TABLE C.—ALTERATION IN EFFICIENCY.

Description of Machine.		Maker's No.	Temp. Cent. F.M. Core. Cold.	Temp. Cent. F.M. Core. Hot.	Current. Cold.	Current. Hot.	Commercial Efficiency. Cold.	Commercial Efficiency. Hot.	Differences. Temperature.	Differences. Current.	Differences. Efficiency.	Mean.
			Deg.	Deg.					Deg.		%	%
Solid Frame.—Armature Plates	Thin.	457	30·5	60	9·745	9·396	79·6	82	+ 29·5	- ·347	+ 2·4	
		924	...	...	10·494	9·899	77·8	81·9	...	- ·595	+ 4·1	
		454	29·4	71·1	10·127	9·705	71·85	74·9	+ 41·7	- ·422	+ 3·05	4·42
		460	38·8	56·6	9·3	10·1	71·82	72·17	+ 17·8	+ ·8	+ ·35	
		462	32·2	66·6	10·313	9·731	70·37	82·56	+ 34·4	- ·582	+ 12·19	
	Thick.	467	33·3	68·2	10·423	9·861	66·74	69·75	+ 34·9	- ·562	+ 9·01	9·01
Rail Pattern.—Armature Plates	Thin.	1846	...	...	10·423	9·988	72·8	74·7	...	- ·435	+ 1·9	
		1840	...	...	10·202	9·783	71·7	82·8	...	- ·419	+ 11·1	6·0
		1849	28·3	65·16	10·239	10·001	69·8	74·81	+ 36·86	- ·238	+ 5·01	
	Thick.	1843	28·8	47·1	10·239	10·089	70·99	73·31	+ 18·3	- ·15	+ 2·32	
		1861	...	...	9·428	9·265	63·87	67·56	...	- ·168	+ 3·69	2·44
		1856	40·5	68·8	10·495	10·129	69·95	68·65	+ 28·3	- ·366	- 1·3	

TABLE D.—DISTRIBUTION OF ENERGY SUPPLIED TO ARC DYNAMOS (No. 7L).

Maker's Number.	Expressed in Watts. Accounted for. 1 Mechanical Friction.	2 C^2R.	3 False induction, &c.	4 Available at Terminals.	5 Total.	6 Absorbed at Pulley.	Not Accounted for. 7 6–5.	8 Per cent. of Total, 6.	Remarks.
1856	338·2	1,376·8	4,011	14,703	19,799	20,108	309	1·53	Machine cold.
460	458	1,029·2	2,720	12,046	16,253	16,765	512	3·05	
462	230	1,223	3,798·4	12,902	18,153	18,331	178	0·97	

TABLE E.

Machine. 1 Maker's Number.	2 Area of F.M. Core.	3 Ampere Turns, F.M.	4 H	5 B	6 μ	Armature. 7 Number.	8 Area of Core.	9 Total Induction.	10 B.	Remarks.
1844	442	43,200	122·8	4,882	36·5	...	78 sq. cm.	2,158,000	27,666	Solid Frame
460	442	43,200	122·8	4,825	39·3	157	78 „	2,132,600	27,341	Solid Frame
1849	442	43,200	122·8	4,647	37·8	161	78 „	2,054,000	26,333	Rail Pattern
1840	442	43,200	122·8	4,692	38·2	152	78 „	2,073,700	26,586	Rail Pattern

Machine cold.

noted, the speed of rotation of the armature being also taken. From the data thus obtained the curves on the diagram (Fig. 4) were drawn. It must not be forgotten that the value obtained for the waste power, corresponding with a given degree of field excitation, does not necessarily represent that which actually takes place when the machine is at work with the given degree of field excitation. The modifying influence of the current in the armature cannot well be estimated. The reduction produced by it in the total induction through the armature core would tend to lessen these losses. At the same time the losses in both armature core and pole-pieces would be increased, owing to the forward rotation of the field by the armature current crowding up, as it were, the lines of force into a smaller space, so increasing the electromotive force of the induced currents, the value of which is always $\frac{dn}{dt}$. Another source of difficulty in the Brush machine is the uncertainty of the effect produced by the great oscillation of the armature field (about 40deg.) owing to the small number of commutator segments. The curves shown in Fig. 4 present some striking peculiarities. The points from which the several curves start on the vertical line for C=0 may be regarded as their respective origins. The power indicated by the portion of the ordinates below this point is due to mechanical friction, and is constant for all degrees of excitation of the field. The curves Nos. 462A and B were taken with the machine cold and hot respectively. It will be observed that less power is wastefully absorbed when the machine is hot than when cold, and

Digitized by Google

that as the two curves start from the same point the difference is not due to mechanical causes. These curves show in the early part a very slow rise in the waste power for a given increment in the field excitation; but as the excitation is increased, the lost power rises with an increasing rate. On the same diagram the curves marked Nos. 1856A and B were taken with increasing and decreasing currents in the field coils respectively. By reference to table C it will be seen that dynamo No. 1856 is one of those in which the efficiency rises and falls with the current in the circuit. The curve taken with an increasing current is the only one of interest. The early portion is peculiar, and I can see no satisfactory explanation of the peculiarity. From the point where the exciting current is 4 amperes the curve is nearly a straight line, which, if produced downwards, would pass through the origin. In this machine, then, the power absorbed driving the armature (on open circuit) through the magnetic field increases directly as the current at least between the values C=4 and C=10. But the power required to overcome mechanical friction is constant. Hence, if the resistance of the circuit remains constant, as it practically does in this case, the efficiency of the machine will rise and fall with the current taken from it. Curve No. 460 was taken from the other machine, in which the efficiency and current rise and fall together. The power absorbed by the armature on open circuit increases at first very rapidly with the current; but when the current has reached 3 amperes the rate of increase is not so great, and it ultimately tends towards a small constant rate of increase.

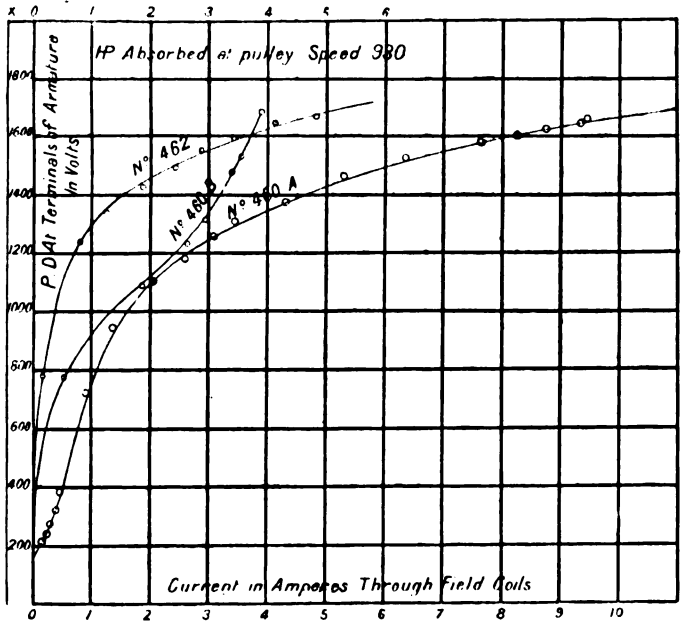

HP Absorbed at pulley Speed 930
P D At Terminals of Armature in Volts
No 462
No 460B
No 460 A
Current in Amperes Through Field Coils

Fig. 5.

Curves given in Fig. 4 express the horse-power absorbed in driving the armature (on open circuit) through the variable magnetic field as a function of the exciting current. This method of representation is purely arbitrary, though convenient when it is simply desired to ascertain the alteration in the power absorbed for a given change in the exciting current. The power required to drive the armature on open circuit through a magnetic field clearly will not depend on the value of the exciting current, but on the number of lines of force which the given excitation can force through the magnetic circuit of the machine. Those lines of force only which pass through the armature produce any useful effect. Consequently, if it is desired to ascertain the rate at which the lost power increases with the useful induction, the curves given in Fig. 4 should be expressed as a function of the total induction through the armature. The curves in Fig. 3 may be taken as curves of induction through the armature, expressed as a function of the exciting current.

The curve of induction through the armature of dynamo No. 460 is shown in the diagram (Fig. 5), and is marked No. 460A. The ordinates of curve No. 460B represent the power required to drive the armature (on open circuit) where the induction through it is proportional to the abscissa. A similar curve from dynamo No. 462, in which the power wasted is also expressed as a function of the induction through the armature, is added for the sake of comparison. The same peculiarities which have been already noticed are now shown in a more marked degree. Curve 460B tends towards a constant ratio between the waste power and induction through the armature. In dynamo No. 462 the waste power increases enormously, with high values of induction through the armature.

The distribution of energy supplied to three of the machines is tabulated on Table D.

The figures given in column 3 are taken from the ordinates corresponding to the given current in Fig. 4. They do not necessarily represent the true value of the loss when a current is taken from the armature. The figures given in the other columns are the result of direct measurements while the machines were actually at work. The data for the curves in Fig. 4 were taken before the machines were started on their respective circuits; they would therefore be comparatively cool. For this reason the distribution of the power absorbed by the machines when cold was selected, so that the values from Fig. 4 would be taken as nearly as possible under the same conditions. It will be seen that the difference between the measured total and the sum of the energy absorbed in the circuit and various parts of the machine is very considerable, especially so in the case of dynamo No. 460. In all three cases the power absorbed at the pulley is greater than that which can be accounted for. Probably this difference is due to an increase in the power absorbed by useless induction when a current is taken from the armature.

In Table E a few approximate data are given with reference to the general condition of the magnetic circuit of these machines. The values given were obtained with the armature running at the normal speed of 930 revolutions per minute on open circuit, the field-magnets being separately excited. In columns 9 and 10 respectively the total induction through the armatures, and corresponding values of B, are given. These and the dimensions constitute the only useful data. In columns 5 and 6 the corresponding values of B and μ for the field cores are given, assuming no leakage to exist. This, of course, is not the case. The figures simply indicate a low useful value of B in the field cores. When the machines are generating a current all the values given will be altered. The actual value of B for the armature of dynamo No. 460 would be 23,028 when the machine is giving a mean current of 10·1 amperes.*

The effect of the fluctuations in the current given by the machines was observed by carefully measuring the current given by the machine and the potential difference at the terminals of the field coils; immediately afterwards the resistance of the field coils was taken. The product of the measured resistance and current gives the potential difference requisite to maintain a steady current of the given value through the field coils. Subtracting this quantity from the potential difference actually measured, the remainder represents the mean E.M.F. due to self-induction.

Dynamo No. 460, hot.

(1) ..... Measured P.D. = 144·04 volts.
C = 11·09 amperes, R = 8·2 ω ∴ C R = 91·00 ,,

Difference ..... 53 ,,

(2) ..... Measured P.D. = 139·0 ,,
C = 9·82 amperes, R = 8·2 ω ∴ C R = 80·5 ,,

Difference ..... 58·5 ,,

Dynamo No. 460, cold.

(1) ..... Measured P.D. = 140·5 ,,
C = 11·33 amperes, R = 7·06 ω ∴ C R = 80·0 ,,

Difference ..... 60·5 ,,

(2) ..... Measured P.D. = 138·27 ,,
C = 10·85 amperes, R = 7·06 ω ∴ C R = 76·6 ,,

Difference ..... 61·67 ,,

From these data it appears that the current fluctuates about 1·5 per cent. on either side of the mean, or a total fluctuation of 3 per cent. If the current were steady the gain in the field coils only would enable the machine to feed one extra lamp with the same armature speed; but the efficiency of the machine would not be much affected.

Of the Victoria Brush dynamos (No. E2 used for incandescent lighting) only four (Table F) were tested to ascertain their commercial efficiency. Much more complete details of the behaviour of this class of machine are given in the various journals than can be found of the Brush arc dynamo. For this reason it was not considered worth while to multiply tests of the Victoria Brush machines. The method of testing was exactly similar to that used for the arc machines, excepting that both pistons in the dynamometer pulley were used, whereas in testing the arc machines only one piston was required.

* Armature E.M.F. = terminal P.D + C R + back E.M.F. in field coils.
= 1,220 + 126·25 + 57·2;
Total = 1,403·45 volts.

Digitized by Google

The very small current taken from dynamo No. 1,587 will account for the low efficiency shown, as the losses are almost independent of the output. As a whole, the efficiency of these machines is less than was expected.

To conclude. More complete tests, to ascertain the magnitude of the various losses which take place in the machines, the values of H, B, and μ, for both fields and armatures, the exact magnitude and form of the fluctuations in the current from the arc machines, and its effect in lessening the output from the machines, are much to be desired. It would also have been instructive to have made a long series of tests obtaining data from which curves similar to those given in Figs. 4 and 5 might be drawn, so ascertaining practically the law in accordance with which the power uselessly absorbed varies. The very considerable differences in the efficiency of the various dynamos, working as nearly as possible under the same external conditions, and having to all appearance similar armatures, is apparent, and the question is, To what are these differences due? It would seem that they must be caused by differences in construction, by which the deleterious reactions in the machines are altered; but if the tests which I have recorded in this Paper could have been extended, and made under various conditions, some light would probably have been thrown on the point. The close agreement of the curves in Fig. 3, and the great dissimilarity of those in Fig. 4, seem to indicate difference in the quality or arrangement of the iron forming the armature cores. There were no spare machines at the Exhibition, the whole number obtainable being in constant use; hence the tests made had to be confined to the shortest possible time, so that the lighting of the building should not be interfered with. This is the reason why further tests were not made, and also for the meagre and somewhat unsatisfactory nature of many of the data given.

TABLE F.—Victoria Dynamos, Hot.

No. of Machine.	Current in amperes.	P.D. at terminals, in volts.	EC / 746	H.P. absorbed at pulley.	Commercial efficiency.
					Per cent.
1823	192·96	108·49	26·06	36·28	77·34
1822	236·66	106·85	33·89	41·82	81·03
1587	90·013	97·66	11·78	17·71	66·52
1825	246·2	110·6	36·5	42·33	86·2

Such as it is, however, I submit this Paper to the members of the Institution of Electrical Engineers with the hope that there may be something in it which will draw forth remarks from some of them whose great experience makes anything they say valuable. At the Spencer-street Railway Station, Melbourne, I have had for some years a small installation of about 60 Brush arc lamps at work lighting the station yard, and I am now arranging for a central lighting station from which about 800 arc and 4,000 to 5,000 incandescent lamps will be lighted. Thirty of the Brush arc dynamos used at the Exhibition have been purchased and will be utilised, most of them being fitted with new armatures, which I will have made upon lines that I hope, and believe, will prove satisfactory. At any rate, I will avoid the evident errors in construction of the armatures sent out from England with these machines. If considered of sufficient interest, I will be glad at some future time to give the result of the work done, and also the details of some experiments made with a view to test the propriety of laminating the field-magnet cores as well as the armatures.

DISCUSSION (Authorised Abstract).

Mr. MORDEY said the author was to be congratulated on the great care with which the investigations described in the Paper had been carried out, particularly as no such tests had been previously made outside the manufactories. He thought, however, that Mr. Murray had given undue weight to the mechanical defects of the "thin-plate" Brush armature, for these defects were discovered at the Brush works before the opening of the Exhibition, and immediately remedied. Again, great stress was laid on the alleged fluctuations of the current from Brush dynamos. Some years ago, when Profs. Ayrton and Perry described their "Discontinuity" Meter before the Society, the speaker made tests on the currents in Brush arc circuits, but no discontinuity was perceived. More recently similar experiments have been made by passing the current through transformers, but no secondary E.M.F. could be detected. Referring to the effects of fluctuations, he could not see how the 3 per cent. variation was deduced from the numbers given, and as a possible explanation of the observed difference between the potential difference and the product C. R., the speaker pointed out that if a perfectly steady current passed through the armature, the Pacinotti projections would induce currents in the field coils. The comparatively low efficiencies of the Brush Victoria machines were probably owing to their being worked below their normal output.

Prof. AYRTON said he thought Mr. Mordey's inability to obtain evidence of discontinuity might arise from his using coils with iron cores and closed magnetic circuits, for in such apparatus very little effect is produced by small changes in the magnetising current. There was no doubt whatever that a great difference existed in the constancy of the currents from the Brush and Gramme machines used with the discontinuity metre.

Mr. MORDEY, in reply, said his 1882 tests were made with open-circuit transformers, and added that even if the supposed fluctuations did exist, they were of no very great disadvantage.

Mr. RAWORTH considered the efficiency tests gave results too variable to admit of much confidence being placed in them, for the many tests made at the Brush Works on various machines were so very regular that they had now ceased to make them. The method of taking the speed seemed open to serious objection, for the power may vary considerably during a minute. A well-calibrated tachometer would have been much more satisfactory. As regards breakdowns from defective insulation, his own experience in exhibition work proved that leaky roofs cause the majority of such accidents.

Replying to some remarks from Mr. Raworth, Prof. AYRTON said he had no desire to disparage Brush machines, and only wished to point out that the evidence of fluctuation obtained by the discontinuity meter received confirmation from Mr. Murray's results. He also added that the Paper under discussion contained internal evidence of imaginary accuracy, for to speak of ordinary commercial measuring instruments agreeing to one-hundredth per cent. was absurd: such instruments could not be read to the degree of accuracy implied by the statements made in the Paper.

Prof. S. P. THOMPSON thought arc and incandescent machines should not be judged from the same standpoint, for as the saturation of the iron is entirely different, the former could not be as efficient as the latter. Referring to fluctuation of current, he said that the two kinds of arc machines in common use (viz., Brush and Thomson-Houston), had both few parts in the commutator, and open-coil armatures. The E.M.F. of such machines must fluctuate considerably, but the large self-induction of arc circuits tends to steady the current. His own experience, however, proved that small Brush machines give fluctuating currents, but he thought the currents from large dynamos working long arc circuits would be steadier. As an instance of the necessity for large self-induction in such machines, a case was quoted where a Thomson-Houston machine refused to do its work when the fields were separately excited. In concluding, the speaker said the relative values of magnetic force and permeability were very disproportionate, and suspected they ought to be divided and multiplied by 10 respectively.

Mr. COUSENS said he had had considerable experience with arc plants in the Colonies, and had found the Brush machine very satisfactory. He had often noticed that the current decreased as the lighting continued, and that the lamps burn steadier as the time goes on. Cold weather also seemed favourable to steadiness. One of the chief mechanical defects he had experienced was the breaking of the commutator connections of shuttle-wound armatures, and when these were strengthened, the wires on the armature broke. Of the latter phenomena he was unable to give an explanation.

Mr. ESSON, speaking of the efficiencies, hot and cold, given in Table C, said he was quite prepared for differences of 2 or 3 per cent., but not for 10 per cent., as in some cases is there shown. The value of the Paper to electrical engineers would be considerably enhanced if the relation between the indicated horse-power of the engines and the useful electrical power had been given. His own experience with Phœnix dynamos driven from countershafting showed that with arc machines 66 per cent., and with incandescents 71 per cent., of the indicated horse-power was available at the terminals. These proportions can be increased by belting the dynamos direct to the engines. In conclusion, he protested against the idea that open-coil armatures were necessary for successful arc lighting, for ordinary Gramme armatures had been made to give 1,500 volts satisfactorily.

Mr. KAPP considered the table of efficiencies very interesting, and thought they deserved careful study. From table A the efficiencies of "thin-plate" armatures were decidedly greater than those with thick plates, thus showing the advantages of lamination. The objection to the use of thin plates, viz., expense, weakness, and space wasted by insulation, were not insuperable, for the additional expense was not prohibitive, and he was glad to hear from Mr. Mordey that the defects of weakness had been satisfactorily overcome. As regards waste space, by insulation, he said that this need not exceed 8 per cent., and that some makers had ceased to use any insulation between the plates. Speaking of the fluctuation of current, he thought all agreed that the E.M.F. of Brush machines fluctuates, and the effect of self-induction was to reduce (not to destroy) the variations in the current.

Mr. ADDENBROOKE, who happened to be in Melbourne at the close of the Exhibition, gave an account of the general appearance of the installation, which he characterised as very neat. From what he heard, the lighting was considered very satisfactory, the arrangement in the picture galleries being particularly good. He was also informed that the transformer plants supplied by Messrs Ganz and Co. and the Thomson-Houston Company worked well. The boilers used were of a combined locomotive and marine type, with tubes and return flue, and the engines seemed to be an exact copy of Marshall's two-cylinder high-pressure type.

Mr. PREECE said Mr. Murray had entrusted him with the care of the Paper, and he was sure its reception would be very gratifying to the author. He himself would have liked more information about the behaviour of the arcs and the amount of illumination employed. Speaking of his own experience in Exhibition lighting, he remarked that in determining the power necessary, he totally disregarded the nominal candle-power of the lamps, and based his estimate on the number of watts per square foot of floor space. As a matter of experience, he found half a watt per square foot gives brilliant illumination, and one-third of a watt was enough for most purposes.

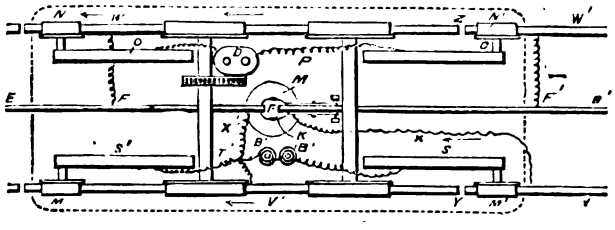
Dr. HOPKINSON (who was in the chair), in confirmation of Mr. Mordey's and Mr. Raworth's statements, said that his tests showed the Victoria dynamo to be very satisfactory, the efficiency being 92 per cent.

Digitized by Google

THE WHELESS ELECTRIC RAILWAY SYSTEM.*

An electric railway system has recently been devised by Mr. Malone Wheless, of Washington, D.C., by which the use of a conduit has been avoided, the conductor being placed below the surface of the street. Experiments are now being carried on in a practical way, which, it is hoped, will demonstrate the success of the plan.

The accompanying illustration shows diagrammatically the system employed, though in practice some of the details have been changed. The conductor *E E'* is laid in a conduit between the tracks and is completely covered, leaving no opening between the rails. Extending from the conduit line, at *f f'*, are wires which are attached to separate rails on one side of the track. By the use of these wires the current can be circuited through the motor and then be led back to the conduit line. The armature *K* of the magnet *M* serves to keep the conduit line closed at *r* by resting against the two ends of the line when the magnet *M* is "dead;" but when the magnet *M* is energised the conduit line is opened by the withdrawal of the armature *K*, and the current seeks the rail *W* through the wire *f*. It then flows in the direction of the arrow into the small wheel *n*, which is supported on a metal arm *o*, and is from there carried to the motor *D*, thence along the line *p* to the metal arm *o'*, and passes down this arm through the small wheel *n'* to the rail *W'*. When the current reaches this rail it must pass back to the conduit line through the wire *f'*, as the opening at *z* gives it no other route. In other words, it will be noticed that the current is simply circuited through the motor on the car by the fact of opening the conduit line at *r*. The supporting wheels of he cart perform no part in the circuiting of the current through the car, as they are made non-conducting by being provided with papier maché centres, and the current flows through the motor from one of the small wheels to the other.



Plan of the Connections of the Wheless Car.

The magnet, which serves to open the conduit line by withdrawing the armature, is energised from a storage or other battery placed upon the car. The two small wheels *m m'* are supported by metal arms similar to those shown at *n n'*, and occupy a distance on the car greater than the length of the rail. In this manner one wheel is always on one rail and one wheel on the next rail. It will be noticed that the wires from the magnet in the conduit are fastened in like manner, *i.e.*, one wire to one rail and the other wire to the next rail. In this way the contact of the small wheels *m m'* with the two rails serves to close the circuit in the conduit magnet as the car moves. The manner in which this is effected is as follows: *B' B''* are cells of the battery carried on the car. From *B''* one wire is led to the metal arm *S*, and thence to the rail *V*, through the small wheel *m'*. Now the rail *V* is insulated from the rail *V'* by the opening at *y*. Therefore, the current traverses the line *x* in the direction of the arrow, passes around the magnet *M*, thence to the wire *x'*. From *x'* it travels to the rail *V'*, pursuing the direction of the arrow to the small wheel *m*, and from there to the metallic arm *S'*; thence along the wire *t'* to the other pole of the battery at *B'*, and the magnet *M* is energised. The result of this, as already shown, is to open the conduit line and throw the circuit around through the motor on the car. This operation is repeated as the car passes over every rail, and a uniform speed is acquired.

* From the *Electrical World*.

The Brazilian Government and the Western and Brazilian Telegraph Company.—It will be interesting to note the attitude of the new Brazilian Government towards this Company in the matter of the dispute with the Director-General of the State Telegraphs over the loop cable which the Company is prevented from laying. Rio advices of October 28th state that the late Minister of Agriculture had contemplated placing a "fiscal" in the offices of the Company. Such a proposal was regarded in Rio as a gross abuse of privilege.

LONDON CHAMBER OF COMMERCE.

The Electrical Trades' Section and the Edinburgh Exhibition.

The following reply to the report of the Special Committee (*The Electrician*, November 15th, p. 33) was received from Mr. Lee Bapty at the meeting of the Section on Monday last:—

To Major S. Flood Page, the Electrical and Allied Trades Section of the London Chamber of Commerce.

SIR: I have placed before my Council the report of your Special Committee on the Edinburgh Exhibition, and am instructed to communicate the decision at which they have arrived as under. The concessions offered are such as have never before been granted, and will, I trust, be found of such a nature that you will be able to recommend them for acceptance by your Section. I need not further enter into the matter of your Section, not having been consulted by my Council before issuing their Prospectus, but would repeat that there was no intentional neglect nor discourtesy meant. The first point of importance is contained in

Paragraph 5.—WITH REGARD TO PAYMENT FOR SPACE, my Council have approved the suggestion I made when attending your Committee on Monday week last, and will undertake to return to exhibitors of electrical inventions, apparatus, plant, &c., all moneys which they may pay to the Council by way of rent for space, provided the net surplus be sufficiently large to enable them to do so, and in the event of a smaller surplus to refund a *pro ratâ* amount. I may say that a surplus is practically certain.

Paragraph 6.—MOTIVE POWER.—My Council are prepared to concede to your wishes with regard to steam or belt-power, which will be supplied free, and with regard to electric current, the power necessary to generate it will be given, but the dynamos should be provided by some of your exhibiting firms.

Paragraph 7.—ATTENDANTS.—I note the suggestion of your Sub-Committee, which is very practical, and I shall be glad to assist in any way I can to reduce exhibitors' expenses in this direction, by allowing the ordinary Exhibition attendants to help your technical attendants when extra manual labour is required.

Paragraph 8.—INSURANCE.—This is a matter which my Council cannot see their way to undertake. Bnt I am instructed to say that every possible precaution will be taken to *prevent* a fire; the most efficient apparatus will be provided, stringent regulations will be carried out, an efficient force of firemen and watchmen will be on duty night and day, and the whole staff will be regularly drilled in fire exercises. I may add that at the Royal Jubilee Exhibition, Manchester, where we had about four millions of pounds' worth of property, not one claim was made, and this I attribute entirely to efficient watching and proper apparatus, and I intend to introduce exactly the same system here, so that the risk of fire will be reduced to a minimum.

Paragraph 9.—AWARDS.—My Council are prepared to practically abide by your suggestion as to awards and the choice of judges, and, in case it should be decided to institute practical tests, will provide the necessary power; but the other costs incidental they think should be borne *pro ratâ* by the exhibitors competing.

Paragraph 10.—TESTING, &c.—My Council concurs entirely in your views, as expressed in this paragraph.

Paragraph 12.—I sincerely trust that, as your wishes have been so fully if not entirely met, the entire trade will now co-operate with us as foreshadowed in the paragraph, and, with your aid, we shall have the finest Electrical Exhibition ever held.

In reference to the request of an extension of time for the entries, which is not mentioned in your Sub-Committee's report, I will bring the matter before the Executive Council, who will have much pleasure in acceding to your request, only urging that, although the closing date will be altered to January 1, 1890, the applications will be sent in *as soon as possible* to facilitate arrangements. The lighting will, of course, be provided by contracts, for which specifications will be at once issued.

I think I have now fairly covered the ground of your Committee's report, and again reiterating the hope that we may now reckon upon your cordial co-operation,

S. LEE BAPTY, General Manager.

After hearing Mr. Lee Bapty's reply, the Committee passed the following resolution unanimously:—

"*That Mr. Lee Bapty's letter be circulated, together with copy of the report of the Special Committee, to each member of the Electrical Section, and each member be requested, not later than December 5th, to inform the Secretary of the London Chamber of Commerce, Eastcheap, E.C., for the information of the Committee, whether he, or his firm, or Company, purpose exhibiting at Edinburgh on these terms.*"

The proceedings then terminated.

Digitized by Google

THE PHYSICAL SOCIETY.

At the meeting of this Society on the 15th inst. Mr. H. TOMLINSON read a Paper on

"The Effect of Repeated Heating and Cooling on the Electrical Resistance of Iron."

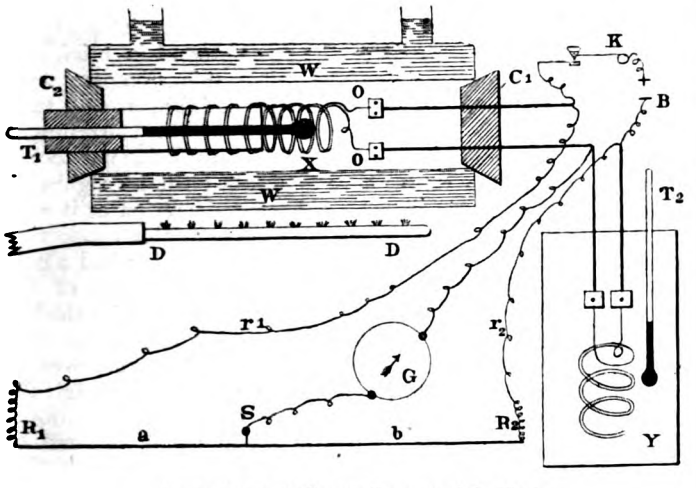
The author began by pointing out that some of the physical properties of iron wire, even after annealing, are known to be capable of considerable modification by repeated heating to 100deg. followed by gradual cooling. For example, the internal friction of a torsionally oscillating iron wire can be permanently reduced to a considerable extent in this manner, and in a Paper recently communicated to the Royal Society the author showed that both the molecular friction and the magnetic permeability of an iron wire could be reduced in this way to one quarter, and less than one-half, respectively, of their original values. There was at the same time a considerable diminution in the temporary temperature effects on both properties.

The object of the investigation described in the present Paper was to determine whether the electrical resistance and the temperature coefficient of iron underwent a similar change as the result of alternate heating and cooling.

According to Matthiessen's formula

$$R_t = R_0 (1 + a\,t + b\,t^2).$$

where R_0 and R_t are the resistances of a metal, and a and b are constants. For most pure metals a does not differ much from ·00366, and therefore the resistance is approximately proportional to the absolute temperature. In the case of pure iron, however, the value of a is much larger, and the author thought that it might, by alternate heating and cooling, possibly be reduced to some value not differing much from ·00366. This, however, was not found to be the case.



Apparatus and Connections used in Tests.

The iron wire was annealed by heating it to a temperature of about 1,000deg. in a tube inserted in a Fletcher tube furnace, and the temperature was maintained at this point for some hours, after which the wire was allowed to cool slowly, without removal from the furnace. This process was repeated on three different days. In order to minimise the effects of the earth's magnetism, the tube was fixed in the furnace in a position at right angles to the magnetic meridian. The wire was about three metres in length and one millimetre in diameter, and, after annealing, it was wrapped round with paper doubled on itself, and then wound into a coil five centimetres in diameter and twelve centimetres in length. It was then introduced into an air-chamber formed of two co-axial copper cylinders connected at their extremities, and enclosing between them an annular space filled with water.

The arrangement of the apparatus is shown in the diagram above.

O O are two clamps, grooved to receive the ends of the iron wire X, and soldered to stout copper connecting rods. A German silver wire, Y, is similarly connected, and enclosed in a glass vessel; $a\ b$ is a platinum-iridium wire, having a resistance of ·1 ohm; R_2 is a resistance of 100 ohms; R_1 a set of resistances from ·1 to 200 ohms; r_1, r_2, indiarubber-covered connecting pieces, each having a resistance of ·05 ohm at the temperature 17deg.; and S is a sliding piece, making contact with any point of $a\ b$, on pressing a button. At the ordinary temperature of the place of observation the resistance of Y was very nearly equal to that of X, and R_1 was nearly 100 ohms; and, therefore, any slight changes in the temperatures of r_1, r_2, and $a\ b$ would not sensibly affect the balance. The temperatures of X and Y were registered by the thermometers T_1 and T_2. The former had its bulb in the centre of the coil X, and was enclosed in the glass tube M, having its end outside the air-chamber lined with indiarubber, so as to allow of the thermometer being pulled out for reading. The thermometer T_1 and the glass tube were both slightly inclined upwards to prevent the mercury column from breaking when the temperature was falling. To maintain a constant temperature inside the air-chamber, the ends of the latter were closed by corks, C_1C_2, and the vacant spaces inside were stuffed with cotton-wool. The water in the annular space W was heated by a row of gas-burners, DD, by means of which it could be maintained constantly at 100deg. for many hours, and very approximately constant for some hours at a lower temperature. G is a galvanometer, B a battery, K a key. As shown in the diagram, the ratio X : Y was determined by means of a Wheatstone bridge arrangement. Instead of closing the battery circuit first and the galvanometer circuit afterwards, as usual in Wheatstone bridge measurements, in order to get rid of the kick due to self-induction, the author preferred to keep the galvanometer circuit constantly closed, which enabled him to get rid of some troublesome thermo-electric effects, and the self-inductive effect was eliminated by extending the observation over two or three seconds.

The bending of the iron wire into the form of a coil, as was to be expected, increased its resistance slightly—about ·25 per cent.—and a small portion of the observed effect was doubtless due to the gradual dying away of this increase. In making the observations the wire was left undisturbed for several hours, and its resistance and temperature determined, after which the temperature was raised to 100deg. as nearly as possible, and maintained at that temperature for at least eight hours, during which period the resistance was measured several times. The wire was then allowed to cool, and its resistance again determined about 16 hours afterwards. These operations were repeated until no sensible change of resistance was produced by the heating and cooling.

The results are given in the following table:—

Number of times heated to 100° C.	Specific resistance in C.-G.-S. units at 17° C. R_{17}.	Differences between consecutive values of R_{17}.	Specific resistance at 100° C. R_{100}.	$R_{100} - R_{17}$.	$\frac{R_{100} - R_{17}}{R_{17}}$.
0	11162	.....	.....	.....	.....
1	10942	220	16029	4952	·4527*
2	10807	135	15796	4922	·4526*
3	10772	35	15789	4985	·4613*
4	10757	15	15747	4999	·4633*
5	10755	2	.....	4996	·4638*
6	10727	28	15724	.....	..... †
7	10711	16	15679	4983	·4629‡
8	10694	17	15674	4965	·4636‡
9	10689	5	.....	.....	..... ‡
10	.....	.....	15654	.....	..... ‡
11	.....	.....	.....	.....	..... ‡
12	10688	.....	.....	.....	..... ‡

* Kept at 100deg. for eight hours; battery current always applied in the same direction.

† Kept at 100deg. for 26 hours; the battery current applied first in one direction and then in the opposite.

‡ Kept at 100deg. for eight hours; the battery current applied first in one direction and then in the opposite.

It will be seen from the table that the specific resistance both at 17deg. and 100deg. was diminished at each repetition of the heating and cooling process until finally it attained a value about 4·5 per cent. less than its original one, so that although the permanent effect on the electrical resistance is much less than on the permeability, for very minute magnetising forces, it is yet quite sensible.

At the sixth heating the temperature of 100deg. was maintained for twenty-six hours, and the direction of the current was frequently reversed, a proceeding which was found to increase the rate of diminution of resistance.

The sixth column of the table shows that the temporary temperature effect on the resistance is not diminished by the alternate heating and cooling, but the temporary increase of resistance per unit becomes greater in proportion as the specific resistance itself diminished. The formula deduced by the author from his observations is

$$R_t = R_0 (1 + ·005131\,t + ·0000315\,t^2);$$

whilst that deduced from Matthiessen's results for pure iron annealed in hydrogen was

$$R_t = R_0 (1 + ·005425\,t + ·0000083\,t^2).$$

Digitized by Google

The author, in conclusion, expressed the hope that the British Association Committee on Electrical Standards might be induced to determine the absolute resistances and the temparature coefficients of the pure metals in general use.

DISCUSSION.

In the discussion which followed the reading of the Paper,

Dr. WALMSLEY inquired what were the magnetic forces for which the permeability of the iron wire was determined? In reply to this the author stated that the magnetising forces were so extremely minute that the permeability might be regarded as sensibly constant.

Prof. PERRY did not consider this assumption justifiable, as the magnetising curve differs considerably from a straight line for small magnetising forces.

Prof. AYRTON thought the author was justified in his assumption, for even if there were a loop in the curve, the points on it would practically be in a straight line if the loop were extremely small, as would probably be the case when the magnetising forces were confined within such narrow limits.

THE LONDON COUNTY COUNCIL AND OVERHEAD WIRES.

The following are some of the powers which the London County Council propose to obtain under their London Subways and Overhead Wires Bill, to which we referred in our issue of October 25th :—

To provide for the removal of all wires in the county of London which are placed overhead, or such of them as the Council may require to have moved, and to require the owners thereof to remove the same, either underground or into the subways, or to such other position as the Council may determine, on such terms and conditions as may be prescribed by the Bill, and to prohibit the placing or maintenance of any tubes, wires, or other appliances over, above, along, or across any street, or within such distance thereof as may be defined in the Bill, except with the consent of the Council, and subject to and in accordance with such terms and conditions as the Council may impose, or as may be defined in the intended Act.

To provide for the registration, inspection, and regulation of such existing overhead wires as may not be removed, and of any wires hereafter permitted to be placed overhead, and to enable the Council to make and enforce bye-laws and regulations, and to require the alteration and strengthening or renewal of overhead wires or supports of overhead wires, and generally to prescribe the materials and method to be employed in placing, insulating, protecting, and supporting such overhead wires.

To enable the Council to remove disused wires, and to require owners of wires to renew, alter, or repair their wires, standards, and supports.

To empower the Council in certain cases to authorise the attachment of overhead wires to houses or buildings, and to provide for determining and assessing what compensation shall be paid to the owners or occupiers of the houses or buildings in respect thereof.

To confer powers upon the owners or occupiers of houses or buildings over or to which wires have been placed or attached, to require the removal or alteration thereof at the cost of the owner of such wires, and in default to provide for the removal thereof, and to impose penalties for breach of any of the provisions of the intended Act, or any bye-laws or regulations to be made thereunder.

To authorise the Council to appoint and employ inspectors for any of the purposes of the intended Act, and to charge and recover fees in respect of work performed by them, and in respect of the registration of wires.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *November* 16, 1889.

The Postmaster-General and the Western Union Company.—There appears to be serious trouble growing between the Government and the Western Union Telegraph Company. In my last letter to you I mentioned that Mr. Wanamaker had reconsidered the scale which he attempted to put into force a few months ago for Government messages, and had established a new rate, averaging about a cent. a word, which he thought might be acceptable to the Company. In advising the Western Union Company of this change in the schedule, Mr. Wanamaker threw out the suggestion that it would be well to have a commission to inquire into the subject, to find out what the service was honestly worth, and to fix rates accordingly. It was supposed that possibly the Western Union Company might accept these new terms without much ado, even if they were still unjust; but it now appears that the great Corporation has no intention of accepting Government work at the rates fixed, without a very strong protest. In fact, it begins to look as though there might be a resort to the Courts if the rates are insisted upon. Dr. Green says that if the entire message business of the Company for the fiscal year just closed had been sent at the rates last named, the total receipts would have been about $4,000,000 less than the actual cost of transacting that work. Taking the Government messages to average 15 cents. each, the total returns of the Company would show the deficit named; while even if the Government messages were much longer than is thus estimated, and should yield an average of 20 cents. each, there would still be a deficit of $2,000,000 on the message business of the Western Union Company. It is hardly to be expected, therefore, that Dr. Green, of the Executive Committee of the Company, should agree to accept the revised schedule. Dr. Green says that the Post Office Department has no right to seize upon rates which the Western Union Company has had to resort to when fighting competition, and use those rates as a basis for charges to the Government. Dr. Green says that the Company has been done injustice before of this kind; but it was ascribed to erroneous judgment. Upon the present occasion, he remarked, however, "A course is pursued which gives your high official sanction to an attitude towards us which we consider so unjust and so well calculated to operate prejudicially to our general telegraph business, that we feel compelled to enter our earnest protest against it." The Company is highly favourable to a Board of Arbitration, and professes itself ready to supply the fullest information as to the cost of telegraphic business. The resolutions adopted by the Executive Committee of the Western Union Company cover the same ground in brief, and wind up as follows:—"Resolved, that this Company will transmit, as heretofore, with due priority and diligence all telegraphs between the several departments of the Government and their officers and agents; but this Company will not accept as final payment the rates above established till its rights in that regard have received such further consideration as it may be able to secure." It is interesting to note in this connection that a few days ago Postmaster-General Wanamaker had a conference in Washington with the postmasters of some of the largest cities in the Union. It is understood that the subject of postal telegraphs was brought up, and that Mr. Wanamaker sought to ascertain how far these officials would be able to carry out his scheme for the delivery of cheap telegrams through the Post Office. There is a general belief that at the opening of Congress next month the subject of postal telegraphs will be brought up, and that Mr. Wanamaker will urge it in his report as strongly as possible.

The Massachusetts Electric Lighting Association.—An interesting new departure in electric light organisation was taken last week in the formation of the Massachusetts Electric Lighting Association. A call having been issued for the purpose, a meeting of representatives of central station companies was held in Boston, when about forty companies, of a total capitalisation of about a million pounds, participated, all the different systems being included. The membership of the new association is limited to general station companies doing an electric light and power business for commercial purposes, and does not exclude gas companies which have electrical interests. The new association settled down to business at once, adopted its by-laws, elected its officers, and is already in good shape to look after the interests of the corporations with which its members are connected. There seems little reason to doubt that this is the first public sign of a movement which is likely to become general, and which will result in the formation of State Associations all over the country. It is, of course, too much to expect that an association will be formed in every State, because in some parts of the Union the material is still somewhat scanty; but we shall probably see several strong State organisations at an early day, and these will be able to do a great deal of good in safe-guarding interests which have often been peculiarly liable to the attack of those who make municipal and State legislation a cover for

Digitized by Google

various forms of exaction. These Associations will in nowise conflict with the work of the National Electric Light Association, but will strengthen that body, and will probably in some way form a part of its membership. It is early yet, I suppose, for the organisers to outline their programme, but I should not be surprised to see the National Electric Light Association in a short time settle down to one meeting a year, while the various State Associations will hold their meetings *ad interim*. In this way activity and vigilance will be continuously maintained, and electric lighting interests throughout the country will be vastly improved.

Senators and Overhead Wires.—During the last week or two the newspapers have, as a general thing, discontinued their wild talk about the dangers of electricity. It is too much, however, to expect that the companies will be let alone for a very long time, and thus we find one of the morning papers canvassing the New York State Legislature to ascertain how the Senators and Assemblymen propose to act in regard to the subject. This paper has asked each of the representatives, first, whether they would favour legislation for controlling the electric currents along our streets within the limit of safety; and next, whether they will join in a conference, irrespective of party, for the purpose of drafting a bill to enforce such control. It is needless to say that a great many of the gentlemen have availed themselves of the opportunity for playing to the gallery. One of them replies, "Count on me to labour for the protection of our workmen and defenceless women and children against the deadly wires." Another one replies very naïvely, "The wires should be put where they will be safest: Edison says the subways will not be perfectly safe, but in this matter I shall be guided by what experts say." One really sympathises with Mr. Edison thus to find him excluded from the noble army of experts. Another Masaniello says, "Too many lives have been sacrificed to the grasping greed of monopoly, and it is high time to put a stop to these outrages." But I refrain, though I could add a number of other responses not less amusing and laughable.

Electric Traction at Boston.—The manner in which the West End Electric Railway Company in Boston is getting ready to equip its whole system with electricity is an earnest of its thorough belief in the advantages of the system, and the desirability of making the change from horses as quickly as possible. Work has been carried on all over the city in connection with the equipment of the circuits, and the central power station is rapidly assuming a business-like appearance. It will contain Thomson-Houston generators, to be driven by thirteen engines, each of 1,000 horse-power, of the Reynolds-Corliss type, and guaranteed to work on 13lb. of water per horse-power per hour. Another interesting feature of this preparation work is the educational process that is going on. Last week, for example, a large number of the *employés* of the Company, together with the various superintendents, were brought together and given a practical lecture by Mr. George W. Mansfield as to the nature and special requirements of the new class of work. There can be no doubt that this lecture will do good, and will give the men useful ideas as to the machinery with which they will have to deal, and the best manner of running it efficiently and economically.

The Patent Laws.—The great increase in the number of electrical patents tends more and more to bring home to the electrical inventor some of the serious defects of our patent system, which, while a good one on the whole, is susceptible of material improvement. It very often, and indeed generally happens, that the prolific inventor is a poor man. At the present time, if he has an invention which he wishes to protect and yet to have time to develop, his only course is to obtain a caveat. This method is, in a measure, costly; and of course, where the inventor's funds are limited, is virtually out of the question. It is now proposed by an inventor, in one of the electrical journals, that instead of the caveat system there should be adopted by the Government a system of safe deposit vaults where the inventor could place under lock and key with the supervision of the Government a complete description and illustration of his invention or process. In this way any number of inventions could be placed on deposit, and, it is argued, all the money and time squandered in disputing and establishing priority would be saved. The proposer of this scheme contends that on account of the greatly increased and complicated matter before the Patent Office, some plan of this kind will soon be a necessity. It is no doubt a fact that the present system of interferences and determinations of priority is open to serious objection, and every new development in electricity only goes to show how great its burdens are. The present conflict over alternating current motors, and the one now arising over the conversion of the alternating into continuous currents, are two examples of the difficulties in the way of satisfactorily determining priority as things are now.

PARIS NOTES.

(FROM OUR CORRESPONDENT.)

November 23, 1889.

The Municipal Station at the Halles, which is to be inaugurated on Sunday next, is due, it will be remembered, to the decree of the Conseil Municipal of July 27, 1888. The 18 months which have elapsed since this preliminary step was taken, have not been wasted, though, perhaps, the work would have got on faster had there been less bickering on the subject of the employment of foreign electrical material. The station is entirely underground. The steam plant comprises 6 Belleville boilers, working at 140lb. pressure, 3 100-kilowatt triple-expansion Weyher and Richemond engines, and 3 125-kilowatt Lecouteux and Garnier engines. The electrical plant consists of 6 110-volt 450-ampere Edison dynamos, running at 600 revolutions, and driven in pairs by the Weyher and Richemond engines, and of 3 Ferranti alternators, running at 500 revolutions, and giving 2,400 volts and 50 amperes. The Ferranti machines are cord-driven by the Lecouteux and Garnier engines, belt gearing being employed in the case of the Edison dynamos. The current for the lighting of the Halles and of the houses in the vicinity will be supplied on the three-wire system by the Edison machines, each pair of dynamos being coupled in series, and all three groups being arranged in parallel. The Ferranti plant is intended for long-distance lighting. The basement of the Halles are lighted by 450 incandescents, while 170 arc lamps, arranged four in series across the mains, are used above ground. The cables, which have been supplied by the Indiarubber, Gutta-percha, and Telegraph Works Company from their factory at Persan-Beaumont, are run under the pavements in cement troughs, the conductors being supported at intervals by enamelled iron hooks screwed into wooden cross-pieces. The authorities propose to supply current by meter at the rate of 15 centimes per 100 watt-hours with a reduction for a larger consumption. The total cost of this station will certainly not be less than £40,000, and no pains have been spared to make it both an engineering and financial success.

The Conseil Municipal have just purchased the Edison Central Station at the Exhibition, and intend to make use of it in connection with the luminous fountains which are to form a feature of the park which is to take the place of the Exhibition buildings. I understand that the capacity of the plant will be increased and the area of supply extended. I may mention in this connection that it is reported that the electric lighting of the Boulevards will probably be continued until March, 1891.

A company, called the Compagnie Nationale d'Electricité, has recently been registered, with a capital of £200,000, to work the Ferranti system in France.

CORRESPONDENCE.

SINGLE-MAGNET DYNAMOS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to the letter of Messrs. Willans and Robinson in your issue of the 8th inst., may I point out that the unequal magnetic pull on the armature in dynamos of the single-magnet class is largely due to the questionable practice of reducing the cross-section of the limbs at the crown of the poles. It has been said that since through *a*, Fig. 1, the magnet has to carry only half the induction, there is no necessity for the cross-section of this part to be greater than half that of the limb at *b*; but when it is remembered that absolute symmetry of the field could only be obtained if the path *e f* were of similar resistance to the path *c d*, the desirability of keeping up the cross-section so as to secure the diminished

Digitized by Google

resistance of a feebly-saturated pole-piece becomes at once apparent. To illustrate these remarks, Fig. 2 may be cited as representing a design in which this point has been kept in view, while from the same standpoint Fig. 1 is a magnetic absurdity.

The magnetic pull may be neutralised by placing the armature eccentrically in the polar cavity, as suggested in a letter of mine published in *The Electrician* of December 9, 1887. The mere closing in of the limbs after boring, to make the air-gap increase both ways from the crown of the poles to the tips, though mitigating the evil to some extent, does not give such satisfactory results as displacing the armature centre.

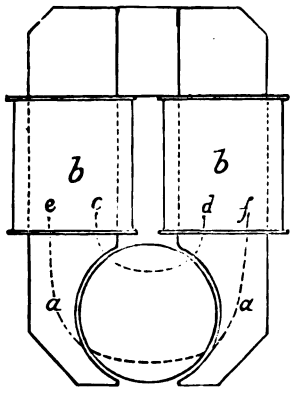


FIG. 1.

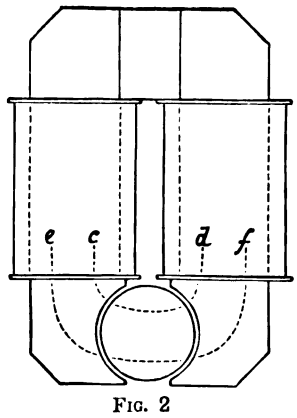


FIG. 2

A new departure in the construction of single-magnet machines with ring-wound armatures has been recently made by my firm. A cross-section of the field is shown in Fig. 3, the magnet limbs and part of the poles being of *wrought* iron, while the top tips, *p*, which are fastened on separately, are of *cast* iron. The object, of course, is to interpose in the path of the induction *c d* through the top half of the armature such resistance as will compensate for its diminished length as compared with the path *e f*.

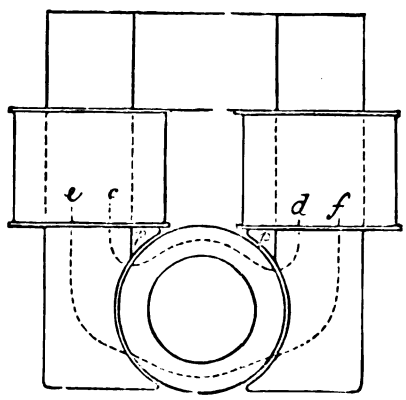


FIG. 3.

This device, which is applicable to drum as well as ring armatures, may be further modified by introducing a gun-metal liner in the joint between the wrought and cast iron, or by altering as may be necessary the shape of the castings.—Yours, &c.,

W. B. ESSON.

London, November 20, 1889.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Having listened for two weeks to the plaintive wail of "Telegraphy" to the effect that no representatives of submarine telegraphy were invited as guests to the dinner of the professional body to which all real submarine telegraph engineers already belong, I beg to offer in your columns a still more bitter cry. Not a single invitation was addressed by the Council to any representative of electric lighting interests, nor to any representatives of the telephonic interests, nor to any representatives of the electric motor interests, nor even to any of the professors at the electrical colleges. Why did the Council perpetrate the extraordinary oversight of not inviting any of these? Strongly as I deprecate the formation of a new Society, the inquiry naturally suggests itself whether an Institution which neglects to invite representatives of three main branches of electrical engineering, and of the budding electrical engineers, can be considered fairly representative. Such a lack of catholicity demands both explanation and apology.—Yours, &c.,

ELECTRIC LIGHT.

LEGAL INTELLIGENCE.

In the Halifax County Court recently, before Judge Cadman, the case of Blackburn v. Smith and Co. was heard. It was an action in which Mr. R. S. Blackburn, electrician, carrying on business at Hebden Bridge, was plaintiff, and Messrs. Frederick Smith and Co., wire drawers, Halifax, were the defendants.

Mr. SHAW, for the plaintiff, said that in the month of April last the plaintiff undertook a contract to construct a line of telegraph at Newhey, near Rochdale. He ordered from the defendants, by letter, one mile of copper telegraph wire, which he instructed them to forward "per luggage" to his address at Newhey. This wire was ordered on April 14th, and was sent off from Halifax on the 24th, and ought thus to have reached Newhey on the following morning. But, in consequence of being miscarried by the Lancashire and Yorkshire Railway Company, the wire did not reach its destination until April 27th (Saturday). By reason of this delay, three men employed there by the plaintiff were kept waiting for the wire. The plaintiff himself lost one day, and also expended certain moneys in travelling in search of the goods. For this loss he sought to claim the sum of £2. 10s. 1d. The plaintiff preferred a claim against the Railway Company for the loss sustained, but the Company declined responsibility on the ground that the wire had been sent by the defendants not according to the ordinary conditions, but subject to the special conditions attaching to the consignment of goods at owner's risk, which conditions relieved the Railway Company from liability "except upon proof of wilful misconduct on the part of the Railway Company's servants." The defendants also refusing to pay, were sued for the loss sustained by the plaintiff, inasmuch as they without his instructions or even knowledge, negligently did consign the wire subject to the conditions as to owner's risk before referred to, and it was not incumbent upon him (the plaintiff) to bring an action against the Company and give proof of such wilful misconduct. Evidence was given by the plaintiff that it was not customary in the trade without special instructions to consign copper telegraph wire at such a perilous risk.

It was contended by the defendants that they were not liable, on the ground that they had consigned the wire according to their usual practice, and that the plaintiff having paid the carriage he was the owner of the wire, and cases were cited in support of this.

HIS HONOUR held that in this case the time occupied in the transit of goods over a distance of about 20 miles was such that the Railway Company were guilty, through their servants, of wilful misconduct, and they were the party thus liable on that account. After further argument, his Honour decided that the defendants having been instructed to forward the goods "per luggage," were justified in forwarding the same at owner's risk, and especially as by so doing they had saved the plaintiff the full rate of carriage otherwise payable. He suggested that the plaintiff should bring an action against the railway company, whom he considered were guilty of wilful misconduct in the matter. He was therefore obliged to enter a nonsuit for the plaintiff.

THE KENT ARC LAMP.

The brake action of the Kent unifocal arc lamp, which is noticeable for the simplicity of its working parts, its lightness and shortness—its entire length being only 2ft. 2in.—is shown in Fig. 1. W is a wheel with three flat-bottomed recesses turned in it, two being for the feed-chains and one for the "break-band." The action is as follows:—The beam B is pivotted on a standard with a fulcrum at F, the arrow showing the direction of motion. When the current traverses the lamp, the plunger P, by virtue of the feed solenoid (not shown here), is brought down on the upper lug or end of the break-band *b*, the other end of which rests on the top of a pin which goes into the spring dash-pot D. The result is a tightening of the band round the periphery of the wheel W, which gives it a slight rotary motion, the effect of which is to separate the carbons. As the arc grows larger by the consumption of the carbons, the main solenoid allows the beam B to move in the opposite direction to the arrows, thus slightly loosening the grip of the break-band on the wheel, which is moved round by virtue of the chain *c* pulling on it, the chain *c* being attached to the upper carbon-holder, to which a gravity bias is given by the attachment of a small weight (about two ounces) fixed to the cross-piece supporting the carbon-holder.

With a 10-ampere current and E.M.F. of 50 volts it is impossible to see the "feed." In the ordinary or "parallel" burning Kent lamp there is but one wheel and one solenoid. For "series" running there is a second solenoid placed in "derivation" between

Digitized by Google

the "live" terminals of the lamp, which helps the action of bringing the carbons together should too little current be flowing through

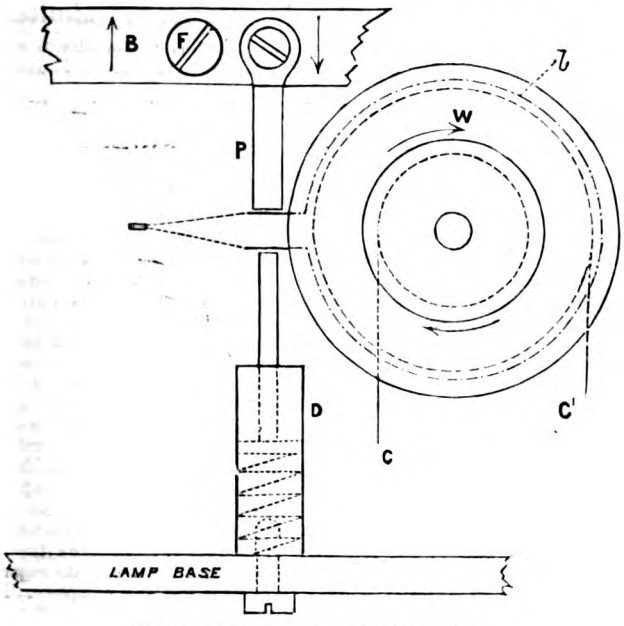


FIG. 1.—Diagram of the Brake Action.

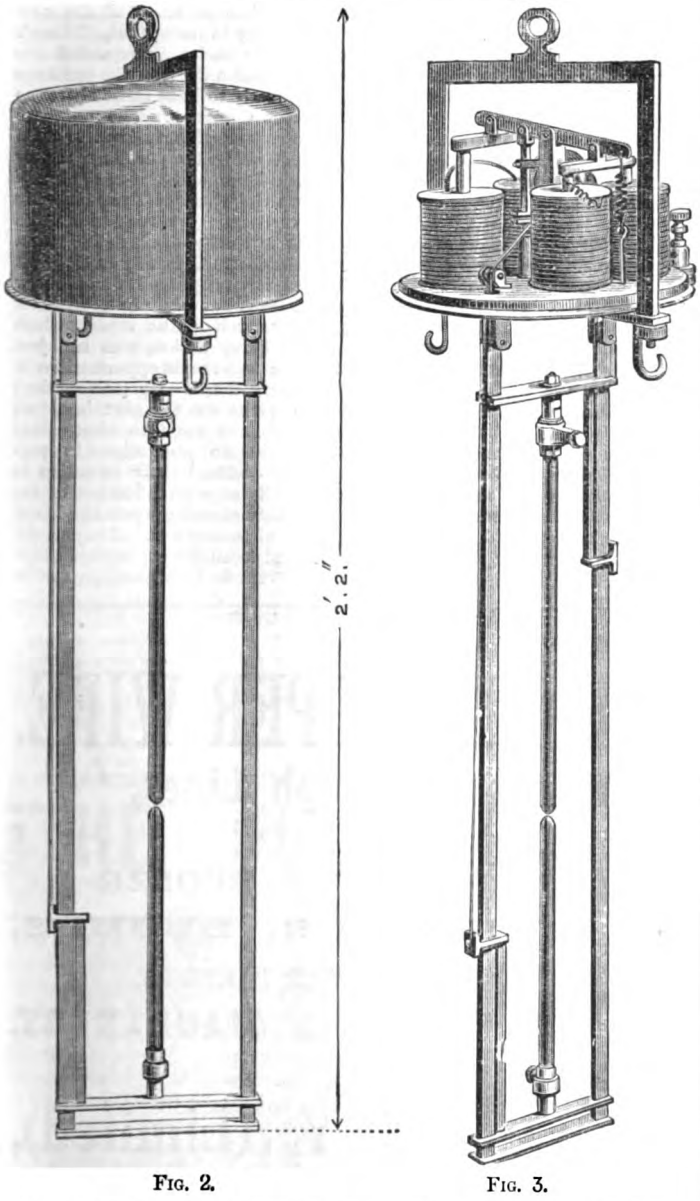


FIG. 2. FIG. 3.

the main series solenoid. The Kent arc lamp (Figs. 2 and 3) is now working on a 65-volt parallel "direct" circuit at "Olympia."

TRADE NOTES AND NOTICES.

Notices for insertion under the above heading must reach the Office not later than first post Thursday morning.]

MESSRS. W. T. GOOLDEN AND CO. — We have received from this firm some lists relating to continuous-current dynamos, magnetic separators, electrical coal-cutting machinery, portable testing apparatus, and resistances for testing dynamos, motors, and accumulators for experimental purposes. They are in most cases accompanied by illustrations and particulars as to price, &c., and are in a handy octavo form.

MESSRS. J. H. HOLMES AND CO.—Amongst the lighting installations recently erected by this firm is that of the Home and Colonial Stores, near the "Angel," Islington. The light gives the greatest satisfaction to both proprietors and customers, the latter having frequently complained of the insufferable heat occasioned by the large number of gas jets necessary to light the large building. We think such an installation worthy a visit from the proprietors of other large stores and provision merchants, as at this season of the year such buildings are usually most uncomfortable promenades.

MESSRS. B. VERITY AND SONS.—At the last meeting of the Board of Guardians of the Strand Union, Mr. James Willing moved that the resolution passed on October 22nd last, deferring the acceptance of a tender for electric lighting for seven months, be rescinded ; and that the report of the General Purposes Committee, recommending the acceptance of Messrs. B. Verity and Son's tender, amounting to £92, be adopted. Mr. Emden seconded. A long discussion ensued, but the motion, on being put to the vote, was lost by a majority of one.

THE LAING, WHARTON, AND DOWN CONSTRUCTION SYNDICATE. —We have received from this firm a neatly-printed illustrated pamphlet, giving full particulars of the Thomson-Houston systems of electric lighting. The pamphlet also contains particulars and prices of dynamos and transformers.

MESSRS. THOMPSON AND REW.—This firm announces that the partnership existing between Mr. N. G. Thompson and Mr. G. H. Rew terminates by the effluxion of time on November 30th, and that from that date the business will be carried on by Mr. Thompson.

MESSRS. W. O. ROOPER AND TOZER.—This is the title of a firm which has recently commenced business as electrical engineers at Greengate, Stafford, with a London office at Pelton-road, East Greenwich, S.E. From a circular just received we learn that the firm has successfully carried out a number of electric light installations, amongst which is the Café Monico, Piccadilly.

REMOVAL NOTICE.—Messrs. Perry and Co., makers of electroliers, &c., of 72, New Bond-street, London, W., will remove after Christmas to their new premises, 17, Grafton-street, Bond-street, London, W.

SCHMIDT-DOUGLAS ELECTRIC COMPANY (IN LIQUIDATION).— Creditors of this Company are required to send in full particulars of their claims to Mr. E. Musgrave, Chartered Accountant, Bradford, on or before December 21st next.

CATALOGUE OF THE ELECTRIC SUPPLY COMPANY (CHICAGO).— This is a bulky volume of considerably over 300 pages. The illustations and typography leave little to be desired, and the list of electrical supplies is most comprehensive, including Cardew voltmeters, Profs. Ayrton and Perry's hot-wire voltmeters, wire of all descriptions, incandescent and arc lamps, switches, artistic fittings, linemen's tools, tachometers, insulators, &c., &c. The last 50 pages are devoted to useful tables and formulæ.

SALES BY AUCTION.—The sale by Messrs. Wheatley Kirk, Price, and Goulty, of the entire contents of the Victorian Engine Works, Chester, has been fixed for December 11th next, at 11 o'clock prompt. Particulars will be found in our advertisement columns.

——— Mr. Joseph Dawe sells by auction this day (Friday) the Materials and Fittings belonging to Douse's Fire Check Company (Limited). The catalogue includes some electrical apparatus. The sale, which takes places at Harbrow's Building Yard, South Bermondsey, S.E., commences at 2 o'clock.

TENDERS WANTED.—The Directors of the Indian Midland Railway Company are asking for tenders for the supply of telegraph battery materials, sulphate of copper, and tube expanders, &c. The tenders must reach the office, 3, New Broad-street, E.C., not later that 12 o'clock noon, on Thursday, December 5th.

——— Similar tenders are invited by the Directors of the Great Indian Peninsula Railway, whose offices are at the same address.

THE GAS JOURNALS AND THE ELECTRIC LIGHT.—As a sign of the times, we may mention that several of our gas contemporaries have come to the conclusion that the moment has arrived when their columns should be open for the reception of advertisements and notices from the electric light supply and manufacturing companies.

Digitized by Google

PATENT RECORD.

APPLICATIONS FOR PATENTS.

November 1, 1889.

17,317. W. T. Goolden and S. Evershed. London. Improvements in electric measuring and regulating apparatus for use with alternate currents.

17,354. L. Milne. London. Improvements in electric railways or tramways.

November 2, 1889.

17,387. J. Oulton and J. Edmondson. Halifax. Improvements in electric meters.

17,424. J. D. F. Andrews. London. Improvements in joints for armoured electric conductors.

17,425. H. Harper. London. Improvements in electric arc lamps.

17,433. E. T. West. London. Improvements in and relating to coin-freed apparatus for administering an electric current and delivering articles.

November 4, 1889.

17,483. W. S. Frost. London. Improvements in electric rotary brushes and apparatus.

17,484. W. S. Frost. London. Electric shampooing and bathing apparatus.

17,511. C. Coerper. London. Improvements in devices for preventing the action of strong electric currents upon weak currents.

17,521. W. Clark. London. Improvements in the distribution and regulation of electric currents (S. Schuckert and Co., through Wirth and Co., Germany).

November 5, 1889.

17,581. H. F. Joel. London. Improvements in apparatus for regulating and commutating electrical currents applicable for use in dynamo electric machines, motors, and meters.

17,610. H. H. Lake. London. Improvements in electric signalling apparatus chiefly designed for police service (F. E. Morgan, United States).

17,611. C. B. Harness. London. Improvements in electro-medical apparatus.

SPECIFICATIONS PUBLISHED.

1888.

17,718. Parker and Rees. Electric cut-outs. (Price 6d.)

17,848. Burger. Telegraph code. (Price 11d.)

17,866. Bowman. Mantles for incandescent lighting, &c. (Price 6d.)

17,964. Siemens Bros. and Co., Limited (Taylor). Electric generators. (Price 6d.)

18,108. Lake (Bergmann). Casings for electric cut-outs. (Price 6d.)

1889.

2,082. Thompson (Griffith and others). Telephone call boxes. (Price 8d.)

6,332. Scott and others. Electric fuses. (Price 6d.)

10,102. Allison (Macdonald). Electric wire, &c., conduits. (Price 8d.)

10,744. De Pass (De Lodyguine). Electric lamps. (Price 8d.)

11,341. Walker and Bracken. Electric meters. (Price 8d.)

12,046. Marquard. Composition for electric insulators, &c. (Price 6d.)

12,082. Jarman. Electric motors. (Price 8d.)

COMPANIES' MEETINGS.

Brush Electrical Engineering Company (Limited).

The statutory meeting of the shareholders in this Corporation was held on Monday, at the Cannon-street Hotel, the Right Hon. Lord Thurlow in the chair.

The SECRETARY (Mr. Emil Garcke) having read the notice calling the meeting,

The CHAIRMAN said that the shareholders must all know by this time the circumstances under which this new Company had been formed. It was not only the Brush shareholders that he had now the honour to address, but those of the Falcon Engineering Company, and he thought he might almost say those of the Australasian Company, which had finally entered into an agreement with this Company, with certain modifications which were contemplated and explained at the last meeting. The Board consisted, as they were aware, of the Anglo-American Brush Directors, including a new member, the Duke of Marlborough, who was one of their oldest and most valued customers. The Duke had had the electric light introduced into his palace of Blenheim, as well as into his town residence in Carlton-terrace, and took the most lively interest in all electrical and engineering works, possessing an extraordinary amount of intimate knowledge in relation to both subjects, so that he (the Chairman) had no hesitation in saying that it would be difficult in a Company like theirs to find a more valuable Director than they had acquired in the person of His Grace. Besides the Brush Board, they had representatives of the two amalgamated companies. The nominee of the Falcon Engineering Works was Mr. Sanderson, who was present; and Mr. Van Tromp, who could not attend, and who was formerly the chairman of the Australasian Company, had joined them to represent the interests of the shareholders of that Company. As regarded their amalgamation with the Falcon Company, it was now complete. They had issued shares to the shareholders of the Falcon Company in the same way as they had issued shares to the old shareholders of the Anglo American Company. They had placed the debentures—£75,000—on the property of the Anglo-American Company, with debentures of the new amalgamated Company. They had had no difficulty in doing that, although naturally it took a little time and tact on their part. As regarded the shares which were to be obtained by the Australasian Company in exchange for their shares, the Directors were perfectly ready to issue those shares as soon as the patents had been assigned to this Company. The purchase agreement provided that shares in this Company should be issued to them to the extent altogether of £31,000—£30,000 being the purchase money and £1,000 representing the expenses of liquidation and the assigning of the patents. For that the Company acquired the whole of their rights in Australia, the Cape, and India. There was some deviation from the original scheme, which was to include also their assets—book debts, plant, and so forth. These were valued by the Australasian Company at £15,000. As the agreement had now been concluded, it was optional for the new Company to take over those assets up to the 1st of January next. Whether they would take them over would depend very much on the report which they would very shortly receive from Mr. Percy Sellon, who had just returned from Australia, where he would have had ample opportunities of ascertaining the value of the plant and book debts. He (the speaker) believed it to be true that a portion of the plant was to a certain extent obsolete, but Mr. Sellon would be able to inform them to what extent that was so. At any rate they were under no obligation to purchase the plant or book debts unless they declared their intention to do so before the date mentioned. That was the only modification of the scheme set before them. He thought they were entering upon the life of this new Company under the most favourable circumstances. They would have all the energy of the new Company added to all the experience which they had acquired in connection with their various undertakings, and he

PATENT
SILICIUM BRONZE AND SILICIUM COPPER WIRE.
The best for overhead Telephone and Telegraph Lines,
AND ALL ELECTRICAL PURPOSES.
Hard Drawn High Conductivity Copper Wire.
ROLLED AND DRAWN
PHOSPHOR BRONZE.
PHOSPHOR BRONZE
BEARINGS, BUSHES,
AND OTHER PARTS OF
ELECTRICAL MACHINERY.
SOLE PROPRIETORS of the British, Indian and Colonial Patents,
THE PHOSPHOR BRONZE COMPANY (Limited),
87, Sumner Street, Southwark, London, S.E.
WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

Digitized by Google

thought it would be the fault of the Directors if they could not now conduct the affairs of the Company so as to return to the shareholders handsome dividends. Beyond that he thought it would be unwise for him to say more on that occasion. There was one point that he might perhaps enlarge upon with advantage, namely, the Falcon Works at Loughborough. They had taken over those works, and the more they saw of them the better they liked them. The Board were spending a certain amount of money in adding to them and connecting other portions to their own uses. They had not put away the branches of the engineering business which the Falcon Company had carried on. They had found on examination that that business was of a very remunerative kind, and they were now carrying on the manufacture of cars and locomotives originally conducted, and he might add that the tools and shops were admirably adapted for the manufacture of the various articles that the Company had to make for its own uses, namely, motors, dynamos, and various kinds of engines for driving electric lighting machinery. There was one other circumstance which induced him to look forward with very considerable satisfaction to the future, and that was the undoubted advance which electric lighting was making, not only in the metropolis, but throughout the whole of Great Britain and the civilised world. They knew that the Board of Trade was at the present time overwhelmed with work, and that it had under consideration 430 applications for Provisional Orders for electric lighting throughout the length and breadth of the land. When they considered what a vast amount of manufacturing of plant and machinery of various descriptions that must entail—and it might be reasonably hoped that the Company would get its fair share of the work—he thought they would have every right to say that it would be the fault of the Directors if they could not now bring the Company to success, and earn good dividends. The actual work in hand at the present moment of paying orders was more by a considerable quantity than the whole of the work they turned out during last year, and every day was bringing in fresh orders. Indeed, their only difficulty was to execute those orders. The works in Belvedere-road were fully occupied, as were also those in the country; and although they did not like to turn away orders, he was sorry that they had been occasionally compelled to do so during the last eight or ten weeks. Of course, it was necessary for the Company to endeavour to provide against such a misfortune, and they were lending their best energies to that end. These things could not be done without absorbing a large proportion of their working capital; but they all knew, as business men, that, if they did not invest their money in a concern, it was hopeless to expect to get anything out of it. They were engaged, however, in endeavouring to draw the correct line where to stop in the matter of getting increased facilities for manufacturing purposes, and the erection of shops. They had, he thought, the advantage on the Board of the advice and counsel of two or three very wise business men, and the shareholders might with some confidence rely on their judgment for drawing that somewhat delicate line at, perhaps, as near the proper place as it was possible to be done.

Mr. H. G. WEIR thought the shareholders must be very much encouraged by the remarks of the Chairman. He wished to know whether they took over from the Falcon Company any patents in connection with electric lighting. He further asked whether the principle of piece work or day work was adopted in the workshops, and whether the Directors had taken care to insert a clause to provide against strikes. What was the cost of electricity to-day as compared with it seven years ago?

The CHAIRMAN, in reply, said they took over no patents in connection with electric lighting. They did both piece work and day work. There were certain things that were manufactured under a system of piece work, and, as in the case of all shops and factories, there were other things that must be done by day work, so that a hard and fast line could not be drawn. As regarded strikes, the subject was one which they had long been in the habit of taking into consideration in contracting to deliver by a certain date. But strikes were not the only things which they had to provide against. There might be such an unavoidable occurrence as their premises being destroyed by fire. But all such risks were provided for in the usual way. As to the cost of electricity, it was a difficult question, and a general answer could not be given to the shareholder's question. At the present time labour was dear, iron was dear, and fuel was dear—much more so than they were some little time back. All these circumstances had to be taken into consideration; but, on the other hand, certain improvements were being made from day to day in the science of electricity which enabled them to do away with some of the costly processes of manufacture, and so on; and in whatever was being done in that direction they were in the forefront.

On the motion of Mr. WEIR, seconded by a SHAREHOLDER, a vote of thanks was passed to the Chairman and Directors, which the Chairman briefly acknowledged, and the proceedings terminated.

NEW COMPANIES REGISTERED.

AMERICAN ASBESTOS COMPANY (LIMITED).—This Company was registered on the 18th inst., with a capital of £50,000 in £5 shares, to acquire mines and lands in Canada and the United States of America. An unregistered contract of the 13th inst. will be adopted.

ECUADOR CENTRAL RAILWAY COMPANY (LIMITED.)—This Company has been registered to construct and work railways, tramways, lines of telegraph and telephones, in the state of Ecuador, or elsewhere. Capital £115,000 in £10 shares, of which 7,700 are Preference shares. The Company is registered by Messrs. Ashurst, Morris, Crisp, and Co., solicitors, 6, Old Jewry.

ORIENTAL ASSOCIATION.—This Company has been registered to take over, as a going concern, the business recently carried on at 16 and 17, Old Cavendish-street, under the name or style of "The Oriental Association," and also to carry on, at the same place or elsewhere, the business of an electric light company in all its branches. Capital, £5,000, in £1 shares, of which four are founders'.

CITY NOTES, &c.

BLACKPOOL ELECTRIC TRAMWAY COMPANY.—At the meeting of this Company, held on Saturday last, the report of the Directors, showing a profit for the year of £2,983, was presented to the shareholders. Out of this sum it was proposed to pay a dividend of 7 per cent., to put £1,350 to depreciation and reserve, and to carry the remainder forward. This was agreed to, and Messrs. Morris and Oddie were re-elected Directors.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended November 22nd amounted to £7,238.

INCANDESCENT GAS LIGHT COMPANY (LIMITED).—At a meeting on Wednesday it was proposed that the Company should be wound up voluntarily. As an amendment Mr. A. Carey moved, and Mr. F. L. Rawson, of the firm of Messrs. Woodhouse and Rawson United (Limited), seconded, that a committee of shareholders should be constituted for the purpose of conferring with the Directors with a view to the reconstruction of the Company. The amendment was adopted, and the motion therefore fell to the ground.

NATIONAL TELEPHONE COMPANY.—The National Telephone Company announce that the certificates for the recent issue of new shares are ready and can be obtained at the office, Oxford-court, London, E.C., in exchange for banker's receipt.

SPANISH NATIONAL SUBMARINE TELEGRAPH COMPANY (LIMITED).—The numbers are announced of 75 bonds, of £100 each, of this Company, which were drawn on Tuesday to be paid off at par on and after December 31st next.

STOCK EXCHANGE.—The Committee of the Stock Exchange have appointed Wednesday, December 4th, the special settling day for Elmore's Foreign and Colonial Patent Copper Depositing Company (Limited), shares, Nos. 1 to 15,000. Application has been made to the Committee to allow the ordinary and Preference shares of the Brush Electrical Engineering Company (Limited) to be quoted in the official list; and to appoint a settling day in, and to grant a quotation to, the Electricity Supply Company for Spain (Limited), ordinary shares, and the National Telephone Company (Limited), additional shares, Nos. 386,876 to 436,700.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended November 22nd, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £5,203.

THE NON-CONDUCTOR OF ELECTRICITY.

WAREHOUSE.

VULCANISED FIBRE,

PATENTED.

This new material is supplied in two qualities, Flexible and Hard.

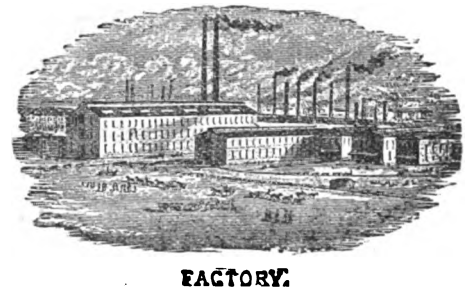
The FLEXIBLE is a substitute for Leather, Rubber, Gutta Percha, &c., and is extensively used by Brass Founders, Axle Makers, Hydraulic, Sanitary, and other Engineers, Pump Makers, Carriage Builders, &c.

It makes the best Hot and Cold Water Packings, and for Axle Washers of all kinds it is unequalled.

The HARD is a substitute for Metals, Hard Wood, Ivory, Vulcanite, Ebonite, &c., and is a good Insulator.

Sold in sheets, 5ft. 6in. by 3ft. 6in., varying in thickness from 1-50in. to 1in.

FLEXIBLE, 2/- per lb.; HARD, 2/3 per lb.


FACTORY.

MOSSES & MITCHELL, 70 Chiswell-st., London, E.C.

Digitized by Google

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Wednesday, Nov. 27, 1889.		Rate per cent. Yielded.	Dividend Due.	Business done during Week Ending Nov. 27, 1889.	
£			**TELEGRAPHS.**			£ s. d.		Highest.	Lowest.
1,770,360	Stock	12/6	Anglo-American	49½	50½	5 8 11	Jan., Apr., July, Oct.	50½	49½
2,614,820	Stock	25/0	Do. Preferred	84	85	6 9 5	,, ,,	84½	84
2,614,820	Stock	...	Do. Deferred	15⅝	16¼	...	February	16¼	15⅞
130,000	£10	5/0	Brazilian Submarine	12⅞	12⅞	5 17 8	Mar., June, Oct., Dec.	12⅞	12⅝
112,900	£100	5%	Do. 5 per Cent. Bonds	101	103	4 16 9	January and July	...	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	106	109	4 11 9	June and December.	...	...
16,000	10	9/0	Cuba Submarine	14½	15	6 0 0	February and August	14⅞	...
6,000	10	10/0	Do. Preference 10%	20	21	4 17 9	,, ,,	...	...
12,931	5	2/0	Direct Spanish (£4 paid)	3⅝	4¼	3 15 4	March & September	...	...
6,000	5	5/0	Do. Preference 10%	9	10	5 0 0	April and October	9⅛	...
60,710	20	3/6	Direct United States	9½	10½	6 16 7	Jan., Apr., July, Oct.	10⅜	9⅞
380,000	10	2/6	Eastern	13⅝	14⅛	4 12 0	,, ,,	14	13¾
70,000	10	3/0	Do. 6 per Cent. Preference	15¼	15⅝	3 16 2	,, ,,	15¼	...
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock	106	108	3 14 1	May and November.	...	...
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	107	110	4 10 11	February & August	...	...
250,000	10	2/6	Eastern Extension	13⅝	13⅞	4 13 8	Jan., Apr., July, Oct.	13⅞	13⅝
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	102	104	3 16 1	February & August	103¾	...
473,000	100	5%	Do. 5 per Ct. (Austrln. Gov. Sub.) Debs. 1900	104	107	4 13 6	January and July	...	...
179,177	10	2/0	Globe Telegraph and Trust	8½	8¾	5 17 1	Jan., Apr., July, Oct.	8⅛	8⅛
178,992	10	3/0	Do. 6 per Cent. Preference	14	14⅛	4 4 11	,, ,,	14⅛	13⅛
150,000	10	5/0	Great Northern	15¾	16¼	4 12 4	Jan., July, and April	16¼	15⅞
17,000	25	12/6	Indo-European	41	43	5 16 3	April and October	...	...
9,000	8	4/0	Reuter's	7	7½	5 6 5	April and October	7¼	...
15,609	10	5/0	West African Telegraph	9⅛	10½	...	...	...	...
300,000	100	5%	Do. 5 per Cent. Debentures	100	103	4 17 1	March & September	...	...
30,000	10	5/0	West Coast of America	10½	11	5 0 0	January and July	10¾	...
150,000	100	8%	Do. Debentures 8%	122	127	6 6 0	June and December	...	...
88,321	10	nil.	West India and Panama	2⅜	3	...	...	2⅛	2⅜
34,563	10	12/0	Do. 1st Preference 6%	11⅜	12¼	...	April and October	11⅛	11¼
4,669	10	+	Do. 6 per Cent. 2nd Preference	14½	15½	...	...	15	14½
45,181	15	9/0	Western Brazilian	9½	10	7 10 3	May & November	9⅜	8⅜
$1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	118	122	5 14 9	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	100	102	5 17 2	March & September	101	...
			TELEPHONES.						
224,850	14/0	5%	Consolidated Telephone and Maintenance	⅝	⅞	...	Yearly	...	...
220,000	£1	3%	Oriental (11s. paid)	7/16	7/16	3 15 11	...	...	...
*	*	nil.	National	5⅛	5⅜	...	...	5⅛	5⅜
55,000	5	3/0	United River Plate	4¾	5¼	...	January and July	...	...
			ELECTRIC LIGHT.						
23,692	5	2/0	Anglo-American (fully paid)	...		...	February & August	...	...
79,934	5	6%	Swan United (£3. 10s. paid)	4⅜	5¼	4 0 0	...	5¼	5
500,000	10	...	Metropolitan Electric Supply (£3 paid)	4¾	5¼	...	...	5¼	
			MISCELLANEOUS.						
87,350	12	12/0	Telegraph Construction and Maintenance	44	45	5 6 8	March and July	46	44
41,600	10	10/0	India Rubber, Gutta Percha & Telegraph Works	18	19	5 5 3	February & August	...	...

† No dividend since May, 1880.

JABLOCHKOFF'S

DISTRIBUTION PATENT

(Being a Patent for "Producing and Dividing Electric Light," No. 1996 of 1877.)

THE UNITED ELECTRICAL ENGINEERING COMPANY (LIMITED)

Are Proprietors of the above Patent, and Warn the Public against Infringement.

The following are Licensees:—

Anglo-American Brush Electric Light Corporation, Limited.
Crompton & Co., Limited.
S. Z. de Ferranti.—London Electric Supply Corporation, Limited.
W. T. Goolden & Co.
Hammond & Co.
Wilson Hartnell.
Johnson & Phillips.
Laurence, Paris & Scott, Limited.
Nalder Brothers & Co.
Paterson & Cooper.
Ernest Scott & Co.
Siemens Brothers & Co., Limited.
J. G. Statter & Co., Limited.

3, Prince's Mansions, Victoria Street, Westminster.

MANVILLE & MADGEN, *Managing Directors.*

Digitized by Google

THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 603.—Vol. XXIV. FRIDAY, DECEMBER 6, 1889. Price Fourpence.

NOTES.

We have received the following cablegram from our New York correspondent, from which it will be seen that it is more than doubtful whether electricity had anything to do with the recent disastrous fire in Boston:

"The theory that the fire in Boston was caused by crossing with an electric light wire is being abandoned, as it was too late in the morning for the arc lights to be running. It is now *suggested* that it might have been caused by contact with electric railway trolley wires, but these wires are more than a mile away, and there is absolutely no evidence as to contact; moreover, they all have guard wires. *It is believed that the trouble with the time signalling wires was caused by the fire*, and did not itself create the fire. Mayor Hart, of Boston, in a communication to the aldermen, is not satisfied that the electric light wires caused the fire, but suggests that, as a guarantee or precaution for the future, safety fuses should be placed on every wire of every class."

Mr. Harness and his Medical Battery Company have lost their "qualified medical adviser," and are not likely to get another. The General Medical Council have ordered Dr. Leeson's name to be struck off the Medical Register "for infamous conduct in a professional respect," he having acted as "cover" for Mr. Harness in the business of a medical electrical practitioner. This is something to be thankful for, but not much. A man who did not scruple in such a business to employ and make the most of a duly qualified doctor, will experience very little difficulty in getting along without one. In the daily papers, only a week after the loss of Dr. Leeson, the electropathic Mr. Harness appears as brisk as ever to the tune of four columns of advertisement; and until the profession of journalism is protected by a Council similar to that representing the medical profession, Mr. Harness and the like of him will continue to thrive on the credulity of the public.

Electric meters depending on the rate of going of a clock, the balance or pendulum of which is electro-magnetically controlled by the current to be measured, are no novelty. The well-known meter of Aron is a mere modification of the meter of Ayrton and Perry, and this, again, is foreshadowed in the early chronographic galvanometer of Watkin. The main complaint against meters of this class is that they require frequent winding. In another column we illustrate a meter from which this source of annoyance is eliminated by the device of substituting slow-torsion pendulums for the ordinary rapid gravity pendulum. Clocks which require to be wound up once a year only are now becoming common in consequence of the introduction of torsion pendulums. The adaptation of the same device to the electric meter brings the apparatus one stage nearer to the requirements of the average practical man, who is still too apt to regard electricity meters as an impracticable fad.

Mr. Bernstein has been most indefatigable in his efforts to perfect his series system of supplying incandescent lamps. He has certainly had every opportunity of getting the system discussed, and probably it is very generally understood by this time. In this week's portion of his Paper will be found a very interesting and very neat proposed application of dynamotors, or motor-generators, as Mr. Bernstein's latest addition to his system.

By the arrangement, which we describe elsewhere, he undoubtedly makes a considerable advance in his system, as regards its applicability to cases where the number of lamps to be supplied is too great to be treated by the direct series connection of 10-ampere lamps. We commend this new feature to the careful attention of our readers. At one time—at the time when Mr. Bernstein brought his system before the Society of Telegraph Engineers—it appeared to us that for scattered districts it certainly possessed some advantages; but, so far, it appears to have failed to gain the confidence of the electrical community, and neither it nor any other system has ever seemed to be able to stand against the very powerful competition of the alternate-current transformer method of working. Whether in the case of Mr. Bernstein's system this has been due to the weakness of any one particular part of the apparatus—dynamo, lamps, line, or accessories—we do not know; but we see no reason to doubt that, with good and reliable lamps, this method could give a very fairly satisfactory account of itself on a moderate scale of working.

Probably the first idea of every electrical engineer who has come fresh to the consideration of the application of electric motors to tramcars, has been that the best place to put the motor was directly on the axle of the car; and it has only become the custom to interpose gearing because sufficient

Digitized by Google

power could not otherwise be obtained unless by the use of enormous motors. It is, therefore, with some surprise that we find a long account in the *Electrical World* of what is called the Baxter car-motor. The illustration shows a car truck fitted with this motor, which apparently takes much less room than an ordinary motor. Indeed, the truck presents the appearance of having no motor on it at all, but a careful inspection, and perusal of the description, reveals the fact that the motor is a kind of thin boxed-in disc on one of the wheels. We are favoured with nothing that merits the term description, so far as the motor is concerned, but are told that the designer claims to have obtained a very strong field in a very contracted space, and that by using on the armature a great number of turns of wire unusually large in cross-section he has secured a high efficiency and large torque. Unfortunately, our knowledge of the physical properties of materials useful in the construction of motors, and some acquaintance with the properties of motors when constructed, lead us to regard with a painful scepticism this latest claimant for our confidence. We do not assert that a tramcar with direct-driven axles is unattainable; but, knowing that well-constructed motors, geared down to an axle driven at a fraction of their speed, have to be forced up to their maximum output, we do say that any one has much to learn, and nothing to teach, who claims to obtain better results out of smaller apparatus driven at lower speed.

Amongst our editorial notes in the issue of November 15th, we commented upon a suggestion of Mr. N. Tesla for obtaining continuous currents from an alternating current. It now appears that devices of a somewhat similar order have been proposed by Mr. E. E. Ries. The devices of Mr. Tesla were of a more or less hypothetical character, and were not acccompanied by any results obtained in practice—indeed, some of them were open to serious doubt whether they could answer the desired end at all. To us it seems that some of Mr. Ries's suggestions are more practicable. One of them consists of a double alternate-current machine having two armatures differing by a half-period; the field-magnet is laminated, and acts as primary to the two armatures as secondaries. If now an alternating current is led around the field-magnet, and *if* the armatures are driven at precisely the proper synchronising speed, they will give off to their respective circuits direct currents. It is ingenious, but is it yet practical? A motor-dynamo to be actuated by alternate currents and to generate continuous ones is at least as practical, and was discussed on this side the water some years ago.

In another column will be found some "new views" upon telephonic disturbances by an American electrician. His experiments present several points of interest and of practical importance. The particular trouble to which our cousins give the quaint but expressive name of "cross-talk" is known in this country, and particularly in London, by the more high-sounding but less expressive name of "induction." As it happens, however, the greater part of the so-called induction troubles in London are due to a conjunction of two causes with which neither electrostatic induction nor electro-magnetic induction has anything to do, namely, a moist and smoky climate and the absurd use of shackle insulators at all possible places along the line. In other words, leakage, through films of dirt accumulating upon insulators of a wholly unsuitable pattern, is the real culprit.

Another cause of cross-talk, not alluded to by the author of the Paper in question, doubtless plays its part in the troubles usually assigned to "induction." We mean the practice of providing a common return through earth for all the radiating lines of a system. If the currents sent through a line flow back *vid* the earth, what is there to hinder a fraction of them from finding their way back through any convenient neighbouring line which likewise goes to earth? Indeed, this is what one would expect to occur. Metallic circuits, with clean insulators of a rational pattern, are singularly free from cross-talk. But the telephone folk throw the blame upon "induction" for all the faults inherent in their system.

The *Electrical World* of November 16th contains a description of a transformer devised by Dr. Leonard Paget, whose object is said to be to remove the reproach from transformers that they are very unequal in efficiency with varying loads. It is generally asserted that, although transformers may be very efficient with full load, they become much less efficient when the load is reduced. Of course the efficiency falls, but we believe that on comparatively light loads a very high percentage is yielded. Our readers will remember that Prof. Ayrton obtained very good results—something like 90 per cent. with one-third load—from a transformer which is probably neither better nor worse than others. Nevertheless anything that Dr. Paget or anyone else can do to give an efficiency equally high for all loads is to be welcomed. But from our reading of the description it appears that if Dr. Paget succeeds in getting a fairly equal efficiency with a considerable range of output, it is not the highest efficiency by any means. We take it that the best result at any and every load with any given transformer will be obtained by using the best magnetic circuit of which the material allows. But Dr. Paget's plan is to vary the magnetic circuit by moving its two iron portions in relation to one another, so that the best condition is obtained with the maximum load. At smaller loads the effect is not so good, the magnetic circuit having a considerable gap in it. From this it will be evident that Dr. Paget has not made a step in advance.

The London County Council is to be congratulated on having taken time by the forelock in the matter of a municipal testing laboratory. As will be seen in another column, £2,000 have been voted for the purchase of apparatus, and the Highways Committee has been empowered to acquire suitable premises. In deciding to appoint an inspector to supervise the main-laying operations at present in progress, the Council, in our opinion, acted very wisely. It is unfortunate,

Digitized by Google

however, that the magnificent salary of three guineas a week was attached to this important post. The entrusting of such onerous duties to an underpaid official does not seem to us either true economy or good policy.

At the last meeting of the Commissioners of Sewers the tender of the Brush Company for the lighting of the Central District of the City was accepted. It was *hoped* that at the next meeting of the Commissioners the question of the lighting of the East and West Districts would be settled. Meanwhile, the Brush Company, whose tender has been, and the London and Metropolitan Companies, whose tenders probably will be accepted, are proceeding with their applications for statutory powers. If these are obtained a pretty complication is promised, in view of the action of the City authorities in having granted electric lighting powers to these Companies without reference to the Board of Trade.

The financial results of the Blackpool electric tramway continue to be satisfactory to the shareholders and encouraging to the advocates of electric traction. Last year's dividend was 4 per cent., this year it is 7 per cent.—£1,350, as against £1,000, being placed to the reserve and depreciation fund, and £235, as against £56, being carried forward. The totals, it is true, are small; but the figures, nevertheless, show plainly what can be done by the adoption of electric traction.

Two occurrences of St. Elmo's fire have turned up during the past week. One of these is a narration of the appearance of the phenomenon at an English east-coast watering place on November 20th last. The other is a brief reference in that extraordinary letter addressed by the Mahdi to Emin Pasha, bidding him to surrender in the name of Allah and the Prophet. Amongst the proofs cited by the Mahdi of the Divine origin of his power is the statement that tongues of fire appeared upon the tips of the spears of his soldiers.

The fire upon the spears of the Mahdi's soldiers is not without historical parallels. According to Procopius, the lances of the soldiers of Belisarius emitted sparks when they were preparing to advance against the hordes of the Vandals. And Cesar narrates how during his African campaign the twin gods Castor and Pollux descended in the form of fire, which streamed from the spears of his famous fifth legion in promise of his victory over the followers of Pompey.

In these days, when nothing is sacred to the man with a camera, photographs of lightning flashes have become quite common. Who will be the first successful photographer to "codak" the fire of St. Elmo?

The official journal of the Spanish Telegraph Department (*Revista de Telegrafos*) contains a report, dated November 12th, of some very remarkable long-line demonstrations in that country of the utility of the Phonopore telegraphs of Mr. Langdon Davies. From Madrid to Saragossa, a distance of 550 miles; from Madrid to Barcelona, a distance of nearly 1,000 miles; and from Madrid out and home through Saragossa, Barcelona, Tarragona, and Valencia, a distance of over 1,100 miles, were the principal circuits employed. Over these distances a diplex and duplex service was established, without the least difficulty or hitch, upon the ordinary telegraph wires, a triplex acoustic service being also superposed upon the same line. The instruments used in the duplex and diplex services were the Phonopore Morse printer, employing the usual method of dot-and-dash on tape. The Spanish telegraph officials, who appear to have been highly gratified with the success of the demonstrations, attest that the transmission was perfect. These demonstrations constitute a departure in harmonic telegraphy that promises to become of utmost importance in the immediate future. The fact that they took place on actual lines of a greater length than the distance from London to Caithness adds to the significance of the achievement.

We call the attention of our readers to the column of Trade Notes and Notices which now appears at the end of this journal, and which will form in future one of its regular features.

Stockton.—Last week the Town Council decided to apply for a Provisional Order for power to supply the electric light.

The Italian Government and the Telephones.—It is reported that the Italian Government intends to take over the telephones.

Paris-Nantes Telephone Line.—It is proposed to erect a trunk wire between Paris and Nantes, a distance of about 250 miles.

Interruption of the Calais-Fano Cable.—The Danish cable is interrupted at a point in the North Sea about 70 miles from Calais.

The Central Station at the Halles Centrales.—This station was opened on Sunday last by M. Yves Guyot, Chairman of the Paris City Council.

Bath.—At a special meeting held last week the Town Council unanimously gave their sanction to the application by Mr. Massingham for a licence.

A Correction.—On p. 86, line 22, of Mr. Bernstein's Paper last week, read "100 volts and ·6 ampere," in lieu of "100 volts and 6 amperes," as printed.

Telephonic Extension.—Portsmouth, Southampton, and Winchester are now in telephonic communication, and the trunk line is about to be extended to Bournemouth.

London County Council.—At the meeting on Tuesday Mr. G. Clement Dunscombe, the city engineer of Liverpool, was elected engineer of the Council, at a salary of £1,500.

Gas Companies and the Electric Light.—The Luton Gas Company and the Sutton, Southcoates, and Drypoole Gas Company are seeking powers to generate and supply electricity.

Municipal Lighting in South Australia.—A Bill is about to be introduced into the South Australian House of Assembly authorising Corporations to erect gas and electric light works.

Postal Telegraph Revenue.—The total receipts from the Telegraph Service paid into the Exchequer from April 1st to November 30th of the present year amounted to £1,550,000, against £1,400,000 for the same period of 1888.

Rise in the Price of Indiarubber.—The price of all qualities of indiarubber has within the last few months risen considerably, and its market value is now double what it was a year ago. The stock in hand is limited, and the supplies continue to fall off.

Digitized by Google

The Sheffield Telephone Exchange.—This Exchange recently passed through its switch room over 69,000 messages, and of these 12,830 occurred in one day. As the Exchange numbers only rather more than 600 subscribers, this may fairly be considered to beat the record.

Fareham.—A largely-attended meeting of gentlemen who have applied for shares in the Fareham Electric Lighting Company was held last week at the residence of Mr. J. Blake. Resolutions were passed to at once register the Company, it having been announced that over 4,000 shares had been applied for.

Local Authorities and Overhead Wires.—In addition to the London County Council, the following Local Authorities seek powers by private Bills to build subways and deal with overhead wires—The Corporations of Bootle, Tunbridge Wells, Walsall, and Sheffield, and the Fleetwood Improvement Commissioners.

Kimberley.—Messrs. Gibson Bros., of Kimberley, South Africa, have obtained from the Town Council a concession for electric lighting in that place. The term is 21 years, and the price to be paid is 1¾d. per lamp per hour. The contractors undertake to be in a position in 18 months from the date of the concession to supply 3,000 lamps, if required.

Barrow.—The General Purposes Committee of the Town Council has decided not to proceed at present with a Provisional Order for the supply of electricity within the borough, and they have also decided not to give their consent to the application of those companies who have already given notice of their intention to apply for Orders. The Corporation owns the gasworks.

Lecture on the Electric Telegraph.—A lecture on the electric telegraph was delivered last Tuesday evening by Dr. Oliver Lodge at the Rotunda Lecture Hall, Liverpool. There was a large audience, which listened with deep attention and interest to an exceedingly lucid explanation of the principles of the telegraph. The lecture was illustrated by a series of interesting experiments.

Royal Society.—Among the Papers down for reading yesterday were the following:—O. Wiener and W. Wedding, Remarks on Mr. A. W. Ward's Paper "On the Magnetic Rotation of the Plane of Polarisation of Light in Doubly Refracting Bodies." H. Tomlinson, F.R.S., "The Internal Friction of Iron, Nickel, and Cobalt, studied by means of Magnetic Cycles of very Minute Range."

Dundee.—An adjourned meeting of the Electric Light Committee of the Town Council was held on Tuesday, when Dr. Hopkinson, who made a tour of the city the previous day, reported verbally the cost of supplying the electric light to the central portion of the city. He expressed the opinion that with an installation of 5,000 lamps the electric light would be quite as cheap as gas.

Electricity in Mines.—On Saturday last a Paper on "The Application of Electricity for Mining Purposes" was read by Mr. T. Vaughan Hughes to the North Wales Branch of the National Association of Colliery Managers at Wrexham. There was a large attendance. Sir Evan Morris presided, and congratulated the colliery managers that they had come together to hear something about electricity.

Newcastle.—At the last meeting of the Town Council, the agreements with the Newcastle-upon-Tyne Electric Supply Company, and the Newcastle and District Lighting Company, permitting them to proceed with their works pending the granting of their licences by the Board of Trade, were presented for sealing. The agreements give the Corporation complete control over all matters in connection with the streets. The sealing of the agreements was agreed to.

Madrid.—A company called the Compania Madilena del Electricidad has just been constituted at Madrid, with a capital of 3,000,000 pesetas (£112,000). Among the directors are Messrs. Rathenau, Siemens, and Grimner, of Berlin. The plans of the new company, as also the new buildings, machines, and lighting installations, have been ordered of the Allgemeine Electricitäts-Gesellschaft. The enterprise is favourably commented upon by the Spanish newspapers.

The School of Electrical Engineering and Submarine Telegraphy.—On Friday last a special lecture was delivered at this School to the students and their friends, by Mr. E. T. Carter (one of the staff), entitled "The Life of the late Dr. Joule, and his Work in Relation to Electrical Engineering." A reference was made to the movement in Manchester for a memorial to Dr. Joule, and various experiments and specially-prepared lantern photographs and diagrams illustrated the lecture.

Fenton.—At a special meeting of the Local Board last week, a resolution was passed deciding that notice should be given to the Board of Trade of the intention of the Local Board to oppose the grant of a Provisional Order to the Midland House-to-House Electricity Company and the Municipal Electric Light and Power Company, the reason for this opposition being the large stake the Local Board has in the existing gasworks. The Board also say that they are ready to supply electricity when occasion demands.

The Copper Market.—The stock of copper in sight now, according to Messrs. H. R. Merton and Co.'s monthly statistics, is a trifle under 100,000 tons. This is the lowest point touched since March last, when the total was 124,876; but is higher than at the end of November, 1888, when the stock was 97,906 tons, and more than double what it was in November, 1887—viz., 45,121 tons. The deliveries last month—which had only thirty days—were 13,415 tons, being nearly as good as in October, which had thirty-one.

Mustard Oil as a Lubricant.—Mustard oil has of late been given some attention as a lubricant, and it is reported to have been successfully used for some time in Germany for lubricating purposes. It is said not to be susceptible to cold, and besides does not easily become rancid or form fatty acids which would attack metal. Its lubricating value, moreover, according to Prof. G. Herman, of Aix-la-Chapelle, is of a relatively high order. No particulars have been yet given as to the cost of the new lubricant, its specific gravity, &c.

Edinburgh Exhibition.—There is every prospect, we are informed, of French electrical firms being well represented at the Exhibition. It is understood that the French Government will undertake the transport of French goods to and from Edinburgh, and that something like 120 electrical exhibits may be expected from France and Belgium, some of them on a large scale, the terms granted to the exhibitors by the Exhibition authorities being exactly similar to those accorded to English exhibitors through the London Chamber of Commerce.

The Late Sir Daniel Gooch.—Probate of the will, with codicils, made in June, 1887, and June, 1888, of the late Sir Daniel Gooch, Chairman of the Telegraph Construction and Maintenance Company, has been granted to the acting executors, his son, Sir Henry Daniel Gooch, and Mr. Thomas Mark Merriman, power being reserved to grant probate to the testator's brother, Mr. William Frederick Gooch, and to his son, Mr. Charles Fulthorpe Gooch, also named as executors in the will. The value of the personality is declared at £653,492. 1s. 1d.

Copper and the Electric Light.—At the annual meeting, yesterday, of the Copiapo Mining Company, Mr. Arthur Holland (the Chairman), speaking of the prospects of the copper market, said that he was connected with several electric lighting companies, and that he foresaw an immense consumption of copper for wires and ribbons. He was told that a mile of the copper ribbon required a ton of the metal. He thought that it was partly owing to this increased demand for copper that the "visible supplies" had gone down so rapidly, the monthly consumption being enormously increased.

Telephonic Extensions in the West of Scotland.—Telephonic communication has been established between Glasgow and Largs; and Skelmorlie, it is expected, will be similarly connected in a week or two. For the convenience of firms in the districts round Airdrie and Wishaw, the National Telephone Company has resolved to open exchanges in these towns on an early date, with communication to all the existing system. A new direct trunk wire from Glasgow to Dundee is now nearing completion, and an alternative and more direct route for the Edinburgh-Glasgow trunk wires has been arranged for.

Digitized by Google

The Hopkins Prize.—The Hopkins prize has been adjudged to Mr. R. T. Glazebrook, M.A., F.R.S., Fellow of Trinity College, for his researches in physical optics. The prize is adjudged by three Fellows of the Cambridge Philosophical Society, nominated by the Council of the Senate once in three years, for the best original memoir, invention, or discovery in connection with mathematico-physical or mathematico-experimental science. This is the sixth award of this prize, the former recipients being Prof. Stokes, the late Prof. Maxwell, Lord Rayleigh, Sir W. Thomson, and Prof. G. H. Darwin.

Aberdeen.—At a meeting of the Gas Committee of the Aberdeen Town Council last week, it was reported by the Town Clerk that the Board of Trade had stated, in reply to a communication which had been addressed to them, that they were not prepared to give any powers by Provisional Order except those strictly within the lines of the Electric Lighting Acts, and that they had also signified their intention of discountenancing all applications by way of special Acts. It was suggested at the meeting that the various Scotch Corporations should make a combined application to the Board of Trade with the view of urging them to bring in a Bill next session to amend the Electrical Lighting Acts and remove the anomaly which prevents the Local Authorities from making electric light undertakings part of their gas undertakings.

Telephone Soiree in Manchester.—A musical *soirée* and ball took place on Tuesday last week at the Manchester Athenæum to commemorate the recent marriage of Mr. Kenneth MacIver, manager of the Manchester district of the National Telephone Company (Limited). There was a large gathering. In the course of the evening the presentation of a gold repeater hunting watch to Mr. MacIver, and a pearl and diamond ring and a silver tea service to Mrs. MacIver, was made by Mr. H. P. Hughes, on behalf of the staff and business friends. Mr. Hughes pointed out that Mr. MacIver had the longest record of any telephone official in the United Kingdom. The subscribers and business friends held Mr. MacIver in high esteem, and there was a bond of friendship between the manager and the staff. Mr. MacIver briefly returned thanks on behalf of himself and his wife.

Proposed Memorial to Dr. Joule at Manchester.—A public meeting was held last week in the Town Hall, Manchester, for the purpose of considering the proposal to erect a memorial to the late Dr. James Prescott Joule. There was a large attendance. The Mayor of Manchester presided, and in his opening remarks spoke of Dr. Joule as a man whom the citizens of Manchester were proud to call one of themselves. Mr. Oliver Heywood moved:—"That this meeting desires to mark its deep sense of the benefits conferred on mankind for all time, as well of the great honour which has accrued to this district, by the scientific work of the late James Prescott Joule, by the erection of a durable memorial of him in Manchester, in the form of a white marble statue." Sir H. E. Roscoe, M.P., seconded the motion, which was adopted. A committee was appointed to raise, by public subscription, a sufficient sum to carry the resolution into effect.

Obituary.—We regret to announce the death, at Shanghai, on November 13th, of Mr. L. M. Holst, the Great Northern Telegraph Company's engineer in the Far East. Mr. Holst entered the company's service in China in 1874, and took an active part in all the company's first attempts to construct land lines and introduce inland telegraphs in the Celestial Empire, until he finally, in 1881, succeeded in completing the construction of the first inland Chinese telegraph line of any importance between Shanghai and Tientsin. Several routes were surveyed and many lines built under Mr. Holst's immediate supervision, and in recognition of his valuable services the Chinese Government decorated him with the insignia of the Double Dragon. In 1885 Mr. Holst was promoted to the post of superintending engineer in Shanghai to the Great Northern Company, which position he held until his death at the early age of 39.

The Lighting of the City.—On Tuesday last a report of the Streets Committee was presented to the Commissioners of Sewers, recommending that the tender of the Brush Company for lighting the Central District should be accepted. The Committee hope to be able to bring up a report at the next meeting dealing with the districts east and west. The contract is for 21 years, terminable at the end of 7 or 14 years, and the price £26 per annum for arc lamps. Mr. Pannell said, having been intimately associated with this question since it was first discussed in the Commission seven or eight years ago, he would like to say that he thoroughly agreed with the recommendation of the Streets Committee. He thought there could be no further objection, as their own requisition was acceded to. They ought to show that they really meant to give these people an opportunity of pressing forward electric lighting in the City of London. The report was adopted.

The London County Council and Electric Lighting.—At the last meeting of the London County Council Mr. F. Westacott brought up a report of the Highways Committee on the subject of electric lighting. The committee recommended—(*a*) That the Highways Committee be authorised to obtain premises suitable for an electric testing station; and also to obtain and fix, at a cost of about £2,100 the necessary apparatus for the station. (*b*) That a competent person be appointed, at a salary not exceeding £200 a year, to discharge the duties of inspector under the Electric Lighting Acts. (*c*) That a person be appointed, at a salary of £2 a week, as caretaker of the electric testing station, and to attend to the accumulators and otherwise assist the inspector. The report further stated that there was at present no means of ascertaining that the conditions imposed by the Council upon the electric lighting companies with regard to the laying of mains were complied with; and the committee were of opinion that a person should be employed to supervise the works of the companies with a view to insuring such compliance. They recommended that a person be appointed at a salary of £3. 3s. a week, to supervise the works of the electric lighting companies in the public streets. The report of the committee was approved.

Proposed Electro-Technical Exhibition at Frankfort.—The idea of holding an electro-technical Exhibition in Frankfort next year, to which we referred in our last issue, has, we are informed, met with the greatest approval, and the undertaking has the best financial prospects. Plenty of space, 538,000 square feet, is at the disposal of the Committee, as it has been found possible to make use of the site of the old railway stations. A special railway line right into the Exhibition will provide a cheap and easy means for the transit of exhibits. The Committee will thus be able to reduce the expenses of the exhibitor to a minimum, and will take care to provide the necessary motive power. As the Exhibition will be an international one, the Committee will endeavour to procure further facilities for the exhibitors by trying to obtain a reduction of freight and duty, in order to induce a universal participation in the enterprise. The Exhibition will include all branches of the electrical science and industry, but only those exhibits will be admitted which show a decided improvement on those of the last special exhibitions at Munich and Vienna. The Exhibition will open on June 1st, and remain open until the last day of October, 1890. It is proposed to divide the exhibits into the following 12 great groups:—(1) Motors for electro-technical purposes, such as steam, water, air, gas engines, &c., steam generators, &c., accessory apparatus; (2) Generators of electricity; (3) All kinds of apparatus for conducting and distributing the electric current; (4) Accumulators, transformers; (5) Devices for transmission of electric energy and its employment for industrial purposes; (6) Electric light and a special section for fittings of all kinds; (7) Telegraphy, telephony, safeguards against lightning, fire, theft, and other dangers, telegraphic fittings for houses, hotels, &c.; (8) Electrical appliances and apparatus for railways, tramways, ships, and nautical science; (9) Electrolysis, electro-metallurgy; (10) Electric apparatus for scientific, measuring, optical, acoustical, and school purposes; (11) Electro-therapeutics, electro-surgery; (12) Electrical literature. For Europe notice of participation should be given before December 20, 1889, and for other countries not later than January 15, 1890. All notifications should be sent to Mr. Leopold Sonnemann, editor of the *Frankfürter Zeitung*, Frankfort-on-Maine.

Digitized by Google

REVIEWS.

The Alternate Current Transformer in Theory and Practice.

By J. A. Fleming, M.A., D.Sc., Professor of Electrical Engineering in University College, London, &c., 8vo., 487 + xii. pp. (London: "The Electrician" Printing and Publishing Company, Limited, 1889.)

All that comes from the pen of Prof. Fleming claims double attention from the fact that its author not only possesses a thorough training in the theory of electricity, but also is continuously in touch with the practical everyday experience of a large electrical manufactory. He is also a master of the art of expressing himself in a manner which a student can follow, and does not wrap up his meaning in clouds of obscurity requiring the intervention of an interpreter to make his words intelligible. His former literary venture, the "Short Lectures to Electrical Artisans," gave a promise of still greater things to come, a promise not disappointed in the quality of the present work. The aim of the reviewer is not to puff a friend's wares on the log-roller's plan, nor to condemn without measure as though he were a disappointed rival, nor yet to make the review a sort of metaphorical trapeze upon which to display his own feats of literary gymnastics; his aim should rather be, on the one hand, to assist the reader to arrive at a judgment whether it is worth while for him in his particular case to purchase or consult the work, and, on the other hand, to assist the author to ascertain how far his work meets the needs of those for whom he writes, and in what way his work can be improved or developed. Incidentally, a review may serve other useful purposes, such as the commendation of helpful innovations, the exposure of popular fallacies, the condemnation of unworthy or obsolete matter, the recognition of merits in forgotten workers, or the criticism of hypotheses which are not yet established upon a basis of actual proof.

It would be very difficult to pick out from amongst the electrical literature of the past ten years any work which marks, as emphatically as does Dr. Fleming's book, the manner in which the practical problems of the day have compelled electrical engineers to advance in their knowledge of theoretical science. In 1884 Lord Rayleigh, as President of the British Association, remarked, in his inaugural address at Montreal, that the introduction of powerful alternate-current machinery was "likely to have a salutary effect in educating practical electricians whose ideas do not rise easily above ohms and volts." The educating influence of alternate-current working, compelling as it does the consideration of problems in the self-inductive action of a current as a factor of at least equal importance with that of the "resistance" of the circuit has been enormous. The fact that the presence of self-induction might, and would, entirely vitiate the readings of a measuring instrument if used on an alternate-current circuit, though when used with direct currents its readings might be perfectly accurate, was a fact which could not be disregarded from the commercial point of view. The strange paradox that in an alternate-current circuit the sum of the currents in two branches of a main might exceed the quantity of current in the main itself was no less true than it was puzzling. Even the simple facts of mutual-induction were almost as little recognised as those of self-induction. The fact that you could draw from the secondary circuit of a transformer a larger number of amperes of current than were supplied to the primary circuit of the transformer by the mains seemed so impossible to the official experts of the United States Patent Office, that they refused to grant a patent to a well-known inventor for an apparatus which should accomplish this now common transformation. This was in 1883. Nevertheless, the same Patent Office which had refused the grant to Mr. Bernstein on the ground of impossibility, issued a patent in 1886 to Messrs. Gaulard and Gibbs for the same thing. It was, therefore, a happy thought of Dr. Fleming to prepare a Treatise which should embrace the consideration, from both the theoretical and the practical aspects, of the transformation of alternating electric currents, beginning virtually where the ordinary simple text-books leave off, and going down *au fond* into those all-essential questions of self-induction, mutual-induction, periodicity, retardation of phase, virtual resistance, and square-root-of-mean-square value, about which neither the ordinary telegraph engineer nor the old-fashioned untrained electrician knows anything, for the simple reason that they do not come within the range of his practice. That the employment of a periodic or alternating current, instead of one of steady uni-directional flow, should almost totally alter the aspect of the phenomena, is due to the fact that when a current, instead of remaining steady, is changing its strength, the changes of strength (and, therefore, the strength itself) are governed not so much by the so-called passive "resistance" of the circuit as by the reactive effects of the magnetic "field" which the current sets up in the space in the neighbourhood of the circuit. The presence of this magnetic action in the surrounding space acts as a sort of invisible fly-wheel on the current, endowing it with a species of electro-magnetic momentum, by virtue of which any change in the strength of the current evokes an active opposing tendency. Dr. Fleming speaks of this property as electric inertia, a not inapt term provided it be remembered that inertia is a property tending to oppose the stopping of that which is moving, as well as to oppose the moving of that which is at rest. It should also be remembered that the so-called electric inertia is due to the presence of the magnetic field or vortex around the current, and should perhaps more strictly, at least in the present state of science, be termed "electro-magnetic."

As yet Dr. Fleming has only published the first volume of his treatise, dealing with the general facts about periodic currents and their induction, and the methods of calculation applicable to them. In the second volume, which will be eagerly awaited by those who have worked through the first, are to be considered the construction, design, and use of induction transformers, the practical measurement of periodic currents, and their application in lighting, welding, and other technical work for which they are suitable. The subject of the design, construction, and theory of alternate-current dynamo machines does not enter into the scheme of the book, an omission which may be readily supplied from other existing works, and which lightens the present work, and enables the whole space to be devoted to the immediate subject in hand.

Dr. Fleming's book begins with a short introductory chapter devoted to the narrative of Faraday's "ten days of splendid and conclusive experiment" in the autumn of 1831, by which he established the main facts about the induction of currents in closed circuits by varying the number of magnetic lines that thread through the space enclosed by the circuit.

The second chapter, on electro-magnetic induction, is of extreme importance, and comprises three main parts: the first dealing with the facts and definitions about magnetic forces; the second with the elementary facts about induction of currents, self-induction in circuits, and the use of coefficients of self-induction; the third part with magnetic hysteresis.

Dr. Fleming is very careful to make his readers think about the so-called lines of magnetic force as corresponding to something more than a mere mathematical conception. He points out how in Faraday's own mind the notion of a "line of force" grew from being a mere geometrical conception until it came to connote not merely a line or direction in space, but a definite physical magnitude, which, though associated with the notion of direction, was also associated with the notion of the product of a certain area of space into a certain average intensity of force over that area. In fact, to put the thing into mathematical language, he came to regard the "line of force" not simply as a "vector" quantity possessing direction *and* magnitude, but as a quantity which was itself of the nature of a surface integral. A simple simile will render the matter clearer. Consider the smoke which ascends a chimney and emerges, spreading into the air above. Consider any cross-sectional area drawn across and around the flow of smoke, either in the wider or the narrower part of the chimney, or in the still wider space above. The total flow of smoke across any such area is the same. The stream-lines of flow of the smoke are sometimes nearer together, sometimes wider apart. The density (or intensity) of the flow of the smoke will not be equal over

Digitized by Google

all portions of any one of the areas considered. Consider any small area which forms part of the old area, there will be a certain average intensity of the flow through this small area. Form the product of the small area into the intensity of the normal flow through it. Then the sum of all such products for all the small areas comprised in the total area may be called the surface integral of the flow, and it is obviously the same thing as the whole quantity of the flow through the area considered. Some writers speak of tubes of induction, or tubes of force, rather than of lines of force; the notion conveyed by the word "tube" being a little more graphic in leading to the conception of the flow through space of a something possessing a physical existence. The whole space in a magnetic field may thus be regarded as being divided up into a set of contiguous tubes of induction, and each tube containing space enough for a single magnetic line to run down its axis; but, as Dr. Fleming remarks, it is simpler in thought to disregard the tubular system, and to speak simply of the lines of induction, or lines of force. Dr. Fleming does not attempt to inflict upon his readers any fine-spun distinctions between lines of magnetic force and lines of magnetic induction, as some ultra-precisians have done. It is true that owing to the peculiarities of grain, &c., in iron, and indeed in all media which are not entirely isotropic (or which, in plain English, have a grain in any direction in their structure), the direction of the lines of magnetisation in the stuff does not always coincide with the direction of the lines as they would have been had there been no such grain. Some people call the lines as they actually are, lines of induction, and the lines as they would have been (if unaffected by grain) lines of force, and then proceed to tell you that though lines of force and lines of induction are not the same thing, they coincide in the case of isotropic media. No doubt such people would smell heresy in Dr. Fleming's use of the two terms as synonymous. The path of a line, or group of lines, of magnetic force is called a magnetic circuit; and the total quantity of magnetic lines in a circuit, considered as passing through a sectional area of the circuit, may be expressed, according to Dr. Fleming, in any one of the following ways, which all signify the same thing:—

"1. The number of unit tubes of induction passing through an area.

"2. The number of lines of force (induction) passing through an area (Faraday).

"3. The (total) magnetic induction through an area (Maxwell).

"4. The *flux* or flow of magnetic induction through an area (Mascart and Joubert).

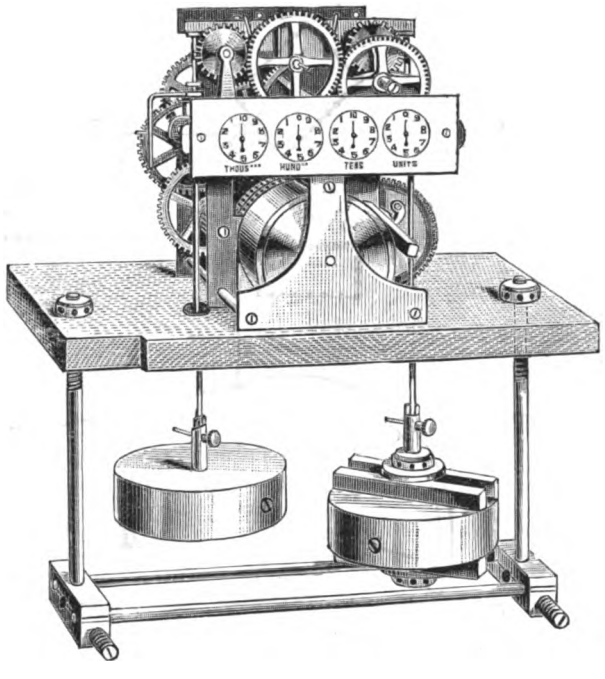
"5. The surface integral of magnetic induction over an area."

(To be continued.)

THE OULTON-EDMONDSON ELECTRICITY METER.

The Oulton-Edmondson meter, which is manufactured by Mr. Joseph Edmondson, of Bradford, consists of a clock having two independent torsion balances, or torsion pendulums, which are set to vibrate identical time when no current is passing. One of the balances carries two or more permanent magnets placed astatically; above, between, or beneath which is a conductor, carrying the current to be measured. Before the clock is started, and when the escapements are at the zero point, the magnets stand at right angles to the conductor. When the clock is running, and the current is passing along the conductor, the latter exerts a quickening or retarding influence upon the magnet-carrying balance, according to the direction of the current. The difference between the speed of the magnet-carrying balance and the other balance is recorded on dials, through a differential gear of novel construction and a registering train. The balances are set to the rate of about 15 vibrations to the minute, and the instrument is calibrated to give a variation between the time of the two balances of one vibration per hour for one ampere-hour, and the readings are proportional to the current through a very wide range. It will measure the smallest current. The meter is calibrated in ampere-hours, each division of the units' dial indicating 10 ampere-hours, or one Board of Trade unit if the E.M.F. be 100 volts. One of the wheels in the registering train is a "change wheel." It has 100 teeth (corresponding with an E.M.F. of 100 volts), and can be changed for one with any other number of teeth up to 120, when the register will indicate B. T. units at an E.M.F. corresponding with the number of teeth in the wheel. This change-wheel is, therefore, termed "the volt-wheel." The meter is contained in a wooden case., measuring 15in. high, 13in. wide, and 6½in. deep, and the whole apparatus is exceedingly compact and portable.

It possesses several advantages over other meters which measure the current by the difference set up in the time of two clocks. It is much more compact. The balances being parts of one clock, and being driven by opposite ends of one and the same spring, are less liable to set up a difference of time than if belonging to two separate clocks, and therefore driven by two separate springs. Only one winding is required, and if the clock be allowed to run down for want of winding, both balances stop together, instead of one of them going on and registering at a great rate for or against the consumer, as has sometimes been the case in meters consisting of two separate clocks. By



The Oulton-Edmondson Meter—Front View, with case removed.

using "torsion" balances the clock can be run at a very slow speed, so as to require winding up only at long intervals. It can be made to run for any time from three months to one year. The torsion balance is so suspended as to be little, if at all, affected in its action by external vibrations, and it will work satisfactorily in positions in which a pendulum would be stopped.

Variations of temperature equally affect *both* balances, and consequently do not affect the record, as only the *difference* of time between them is registered. The use of magnets mounted astatically tends to preserve their magnetism from variation, and reduces the range of external influences. The loss of E.M.F. in measuring the current is inappreciable in its passage through the short straight conductor, which gives ample force for the measurement.

The calibration of the instrument is easily affected by passing a constant current through the copper rods, and varying their distance from the magnets. To convert the meter into a wattmeter we have, of course, only to substitute fine wire coils for the permanent magnets, in which case the instrument can be used for alternating as well as continuous currents.

Digitized by Google

ON THE DISTRIBUTION OF ELECTRIC ENERGY BY MEANS OF CONSTANT CURRENT.

BY ALEXANDER BERNSTEIN.

(*Concluded from page 87.*)

We continue this week our translation of the Paper read before the Electrotechnical Society of Berlin by Mr. Alexander Bernstein.

The system as described here has already met with considerable success, although many of the details have only lately been brought to their present perfection. For the lighting of large areas it is not possible to devise a simpler arrangement, which is at the same time so easily superintended. To this must be added the cheapness and the small loss of energy in the conductors, and the high efficiency of the lamps. It is, therefore, easily seen that such a system was sure to prove useful for the lighting of large factories, mines, stations, streets, and similar cases. For the latter application the use of glow lamps has the additional advantage that the light can be regulated from the central station according to the requirements of the various hours of the night, which is not possible with arc lamps. I may add the remark that the practical advantages of the system have already shown themselves in cases in which the question of distance did not come into consideration at all. However, the number of lamps which can be placed into a single circuit of this kind is limited, as otherwise the total tension would be too high. In regard to the tension, which may be admitted, we must, of course, make a difference between a series and a parallel system: in the latter case the maximum tension exists all over the plant; in the series system the maximum tension is only on the terminals of the dynamo. According to my experience I am inclined to consider a tension of 1,500 volts on the dynamo as perfectly safe; this, however, depends somewhat on the place in which the lamps are to be used, and no general rule can be laid down. In the United States it is now the custom to use twice this amount of tension; but I doubt whether it has been a wise thing to go as far as this, and I think it would be well to consider 1,500 as a limit, in order to insure good insulation, which is the necesary condition of safety. Under these circumstances, the number of lamps which can be placed in one circuit is limited; and if we have to place a large number of lamps, it is necessary to divide the whole plant into several separate circuits, each of which has the form shown in Fig. 1. This has certain advantages. The larger number of engines and dynamos, each of which may be connected to any of the circuits, are a safeguard against breakdowns; but if we have to deal with very large installations, such as are required for the lighting of towns and private houses, a system of this kind would hardly be practical. We are then obliged to enter into a modification of the system, for the purpose of increasing the size of the dynamos and engine, and reducing their number; and further, in order to reduce the tension in each house to such an amount as can be considered safe for use in private houses. We now arrive at the system of constant current with transformers: such a system is shown in Fig. 6. A is the steam-engine, which is provided with the electrical governor; B the dynamo; C the main conductors in the streets; and D_1, D_2, D_3, &c., the transformers, which are placed in the main conductors; E_1, E_2, E_3, &c., are the house circuits, in which the lamps or other apparatus are arranged in series again. It will be useful to first of all consider the peculiar conditions under which such transformers for constant current are situated, conditions which greatly increase their practical usefulness. A transformer consists of a combination of motor and dynamo, and it is, therefore, apparent that there might be as many modifications in the form of a transformer as we have now in dynamos. The drawing, Fig. 7, is merely to illustrate the principle, and does not indicate the form in which I hope to show to you shortly the transformer in operation. In the drawing the armature of the motor, which is provided with thick wire, and the armature of the dynamo, with coils of thin wire, are entirely separated, and both move in a common magnetic field, which is excited by the current in the primary wire. The shaft of both armatures is situated in bearings which are provided with self-acting oiling arrangements. There are a variety of such arrangements already in use, and in this case the requirements of oil are very small, as there is no one-sided pressure on the bearings, and all the internal electrical forces completely balance themselves in regard to the shaft, so that the friction merely results from the weight of the small armatures. Let us now consider the function of such a transformer.

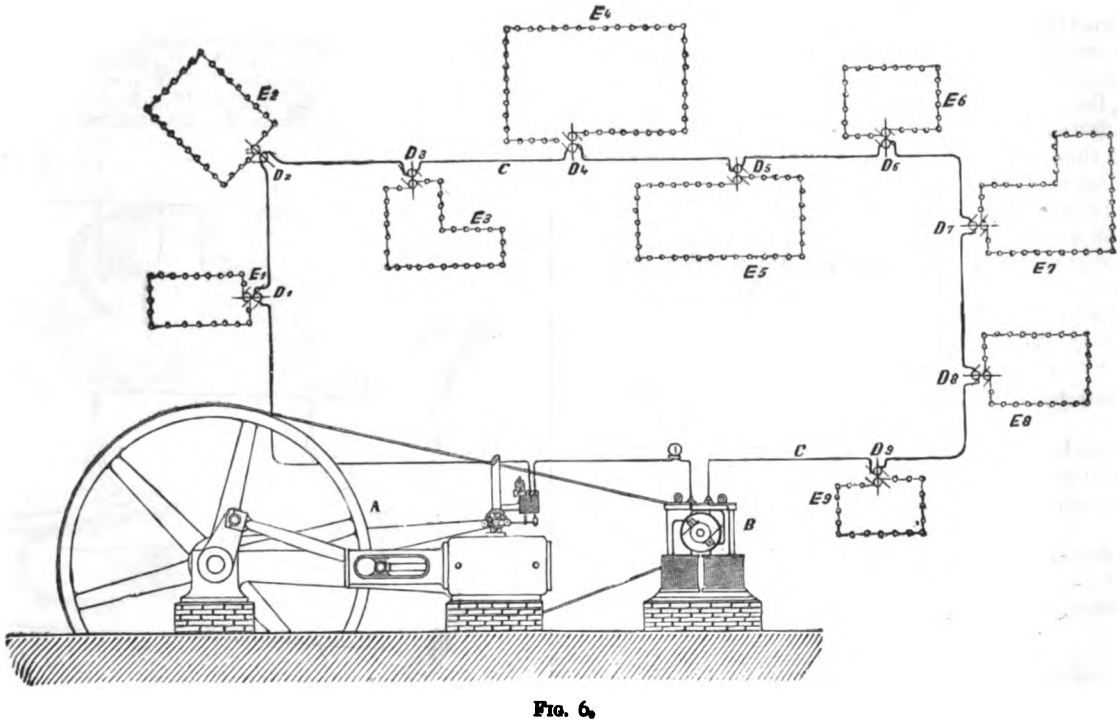


FIG. 6.

The force which must be supplied in order to turn the primary armature under a field of given and constant strength, depends on the current in this armature. This current is kept constant by the means described above. This turning force is resisted by the current in the secondary armature, if we neglect the friction which only absorbs a small part of this force. The current in the secondary armature, which is equivalent to this force, depends on the number of turns of the wire on the

Digitized by Google

secondary armature, in proportion to the number on the primary armature. This proportion being given, the strength of currents are determined which hold each other in equilibrium; or in other words, a constant current in the primary produces a constant current in the secondary circuit. The E.M.F. of the secondary circuit depends on the number of revolutions of the armature, as the field remains constant. Under these circumstances the following will occur:—If, for instance, the primary current is 50 amperes, and the armatures are wound in such a way that a current of 50 amperes in the primary armature is counterbalanced by a current of 10 amperes in the secondary armature, the transformer will assume the speed which produces the 10 amperes in the secondary circuit, because only then the state of equilibrium is obtained. Supposing that with 100 revolutions per minute, and a resistance of 10 ohms in circuit, the E.M.F. is 100 volts, and therefore the current 10 amperes, if now by the addition of lamps the resistance is increased to 20 ohms, the velocity of the transformer must increase also, and now becomes 200 revolutions, in which case the E.M.F. is 200 volts and the current again 10 amperes. The reverse would have taken place if the number of lamps had been reduced. It therefore follows that the transformer in this case has the peculiarity of running at full speed if all the lamps are in use, and of reducing its speed according to the number of lamps which are extinguished. This peculiarity greatly diminishes the wear and tear, and is of considerable practical importance. But there are other circumstances of equal importance which much favour the use of these transformers. In every transformer it is a necessity that the insulation between the primary and the secondary can be well maintained. This is very difficult in a parallel system, in which the high difference of potential, 1,000-2,000 volts, consists everywhere in the circuit, and, therefore, between the brushes of the primary armature. But in the case under consideration, the difference of potential on the commutator of the primary armature is only small. If we, for instance, require a power of 3,000 watts, this difference would only be 60 volts under the conditions assumed above. This makes it perfectly easy to maintain insulation, and, further, to prevent sparks in the commutator. I have already mentioned that the position of the brushes need never be altered in constant-current dynamos; the same is, of course, the case in the transformers. These three peculiarities of the transformer for constant current, viz., the fixed position of the brushes, the small difference of potential in the primary armature, and the change of speed according to the requirements, allow this application of the transformer to be made on which this system is based, because an apparatus which works under so favourable circumstances may be left to itself for weeks, and a periodical, say, monthly, inspection by an attendant is quite sufficient.

I shall now turn to an objection which may be made against this arrangement, and this is that the continuity of the primary circuit is made dependent on the contact of the brushes against the primary collector. Although there is no reason why these brushes should not make contact, as it is easy to devise means which take up the wear of the brushes, I shall suppose that no provision for good contact is made; we can then apply an apparatus which I have used in former years to prevent interruption of the circuit in case of breakage of a lamp. This apparatus consists of an electro-magnet of high resistance, which comes into action if the resistance of the main circuit is unduly increased. The action of this magnet then consists in disengaging a spring or weight which short circuits the primary armature. In this way the faulty transformer is excluded, without in any way disturbing the others. I have already explained that the speed of the transformer will vary according to the number of lamps: this point now requires some further consideration. The secondary armature moves in a constant field, and the E.M.F. is therefore proportional to the speed. The secondary current is constant because the primary is constant. It therefore follows that the number of revolutions of the transformer are a direct measure of the electrical energy which is consumed in the secondary circuit. As a meter the construction of which has never yet received a satisfactory solution in the parallel system, we simply use a registering speed counter attached to the shaft of the transformer. This meter does not register exactly according to the number of lamps which are used, as it measures the total energy consumed, and this is higher in proportion if the number of lamps is small; but this is in accordance with the usual practice, only that in place of an arbitrary scale we have one which corresponds to the expense at the central station. It will hardly be possible to construct a simpler or more rational meter for electrical energy. It is, of course, to be understood that every transformer is provided with a short-circuiting hand-switch, which cuts off the current from the primary armature in case no lights are required in the house.

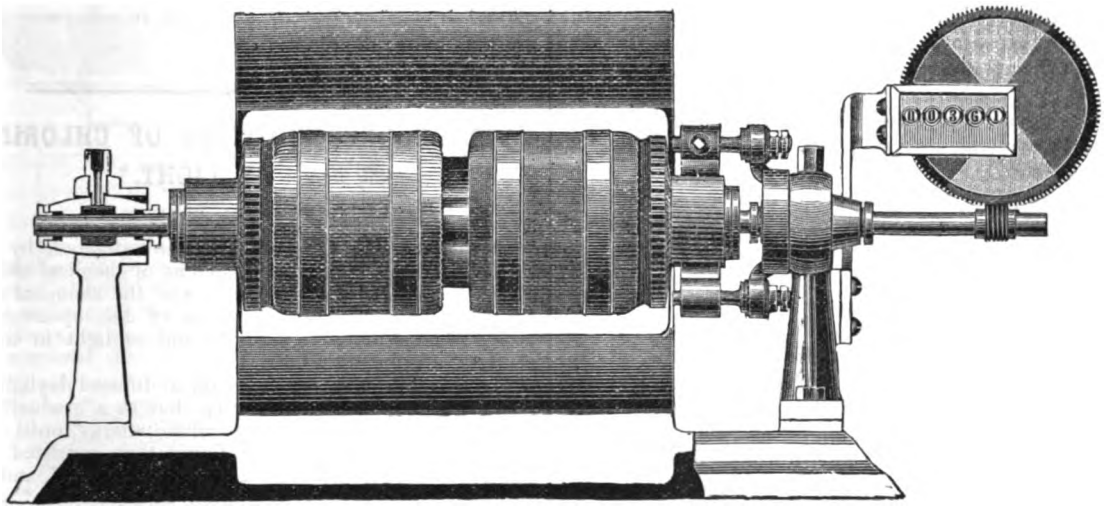


FIG. 7.—Constant-Current Transformer, with Watt Meter attached.

I wish to add here a short remark concerning the alternating current transformer. Those who have advocated the alternating current system will undoubtedly say that the alternating current transformer is more economical than the one proposed here, and they will point to extraordinary results of efficiency which have been obtained by mathematicians; but in spite of these results, the commercial efficiency of these transformers is not any higher than could be expected. In fact, there is no reason why there should be any large difference in favour of the alternating current. The internal resistance is smaller in this kind of transformer, but there is against this the loss due to rapid change of magnetism in the iron. Supposing even that with full load there is a slight difference in favour of the alternating current, the probability is that with half the load the advantage will be on the side of the continuous constant current transformer, arranged in the manner which I have described, as against the alternating transformer in a parallel system.

Digitized by Google

I now turn to the consideration of the secondary circuit. In speaking of the simple-series system I have mentioned 10 amperes as the standard current; but in the transformer system we can use any current in the secondary which answers our purposes. If we have to deal with the lighting of private houses, in which lamps of 8 to 10 candle-power are required, we can use 5 amperes in the secondary, and we can then produce these lights with considerable efficiency, which it is well known is not possible with lamps of 100 volts placed in parallel. For large buildings 10-ampere lamps would be used, and we can then place arc lamps in series with them. In order to obtain a steady light in arc lamps, it is better to supply them with constant current than to put them into a circuit of constant potential. Furthermore, we have to waste considerable energy in resistance in the latter case. I need hardly mention that motors can be placed in the secondary circuit. There are many cases in which the use of accumulators is very desirable for lighting purposes. Probably we shall see charging stations for accumulators for the purpose of propelling street cars sooner or later established in large cities. Now, for charging accumulators it is just constant current that we require and not constant potential; in the latter case we require special arrangements to obtain a constant charging current. The placing of accumulators in the secondary circuit is likely to be the only method which will prove to be practical. It has often been tried to charge these accumulators by means of a high-tension circuit in order to obtain a low tension in the discharging circuit, but the very large damp surfaces of the cells makes it impossible to maintain the degree of insulation required for high-tension currents, and insulation is *conditio sine quâ non* in every system of distribution. A system in which accumulators are placed directly in a high-tension circuit is not only wasteful as far as a current goes, but it contains an element of danger, leaving out the other technical difficulties connected with such a system.

After considering all the various parts of the system, the constructing of a central station plant is easily understood. I shall suppose we have to deal with a plant of 9,000 20 candle-power lamps, or a corresponding number of electrical devices requiring the same amount of energy. The central station contains seven dynamos of 2,000 volts and 50 amperes each, of which one is a reserve dynamo, and each one is driven by a separate steam engine. The whole district is divided into six separate groups, which form independent circuits. In each group 1,500 lamps may be in use simultaneously, and for the sake of simplicity I shall suppose that all transformers are of equal size, namely, each for 50 lamps: we then have 30 transformers in each circuit. If all the lamps are in use, all the engines, dynamos, and transformers have automatically assumed their full speed. In the same measure in which lamps are extinguished in the single house circuits, the corresponding transformers will reduce their speed and react on the engine in the central station. If the consumption of light or power is reduced to a minimum, all the steam-engines will have assumed a crawling motion, which they maintain until the consumption is raised again. All we have to attend to is the management of the plant, to keep steam, oil the bearings, and an occasional inspection of the transformer, which may be done by the same attendant who notes the consumption of energy in each house. Comparing this with the management of a station on the parallel arrangement, with a multiple number of conductors, the great simplicity is very apparent. In the latter case the approximation to constant potential is only obtained by the more careful attention at the central station for the purpose of regulating the supply of energy through each feeder, and the success is constantly dependent on the care which is bestowed to this regulation, besides the attention which has to be given to properly load each dynamo.

If, now, we sum up the advantages of a system of constant current, we can consider these to be mainly as follows:—(1) The possibility of lighting at long distances, and therefore the placing of central stations outside large centres. (2) The economy in regulating the speed of the motive power according to the requirements. (3) The small amount of attendance which is required at the central station. (4) The cheapness of conductors in the streets and houses. (5) The avoiding of fire by overheating of wires. (6) The greatest efficiency of the lamp. To these we have to add all the other advantages to which I have alluded in my Paper.

I have abstained from making any comparison with the alternating-current system, except when I spoke of the transformer itself, but I feel convinced that a system using continuous currents, and having the advantages of the alternating transformer system, must ultimately prove the superior of the two. The use of alternating currents is certainly open to very serious objections, such as the great difficulty of maintaining insulation in cables for high-tension alternating currents, and the great expense of cables suitable for this purpose; the greater danger which is peculiar to alternating currents, even of comparatively low tension; the smaller efficiency of the dynamo and of motors, as well as arc lamps, and the impossibility of charging accumulators—all these are objections which are strongly against the use of alternating currents. I think the alternating current will repeat its history in the development of electric lighting. We have once before seen the alternating current in prominence in connection with the Jablochkoff candle—which, however, has made way for the arc lamp, in spite of the greater complications of the latter. I have no doubt that the alternating-current transformer will again be replaced by a continuous-current transformer. The progress of electrical science gives us the means to carry out constructions which in former years would have been considered as impracticable. The system of distribution by constant current presented far more difficulties to be overcome than have presented themselves to the system of constant potential, when first shown. But I hope that the explanation which I have given in this Paper will induce electricians to consider more clearly all the advantages which are offered by such a system, and that it will pave the way to its more general introduction.

RATE OF DECOMPOSITION OF CHLORINE WATER BY LIGHT.*

BY DR. G. GORE, F.R.S.

In this research the author has investigated, by means of the voltaic balance, the kind and amount of chemical change, the rate at which decomposition proceeds, and the chemical composition of the products formed at all stages of decomposition of chlorine water, when exposed to daylight and sunlight in colourless glass vessels during many weeks.

The chlorine water, by exposure to diffused daylight, was decomposed with moderate uniformity, but at a gradually diminishing rate, as shown by the losses of voltaic energy, until no further loss of such energy occurred; the liquid then consisted of an aqueous solution of hydrochloric acid, hypochlorous acid, and chloric acid. By further exposure of the liquid to daylight and sunlight during several weeks, peroxide of hydrogen was formed, and the amount of hydrochloric acid and of voltaic energy very slowly increased until that of the latter became about equal to that of dilute hydrochloric acid of equivalent strength to the whole of the chlorine present. All the other chief properties of the final liquid agreed with those of a mixture of dilute hydrochloric acid and peroxide of hydrogen. Still further exposure to strong sunlight caused no further change in chemical composition, amount of voltaic energy, or other property of the liquid.

This research shows distinctly that the decomposition of chlorine water by light may be divided into two essentially different parts or periods of chemical change, and that the kinds of chemical change occurring during these two periods are largely different. During the first period a very great and gradual *loss* of voltaic energy occurs, attended by formation of hydrochloric, hypochlorous, and chloric acids. During the second period, a moderate and very slow *increase* of voltaic energy takes place, accompanied by decomposition of the hypochlorous and chloric acids, a further formation of hydrochloric acid, and the production of peroxide of hydrogen. Under the influence of prolonged sunlight, the whole of the oxygen of the hypochlorous and chloric acids united with water to form peroxide of hydrogen, and the peroxide then combined with the whole of the hydrochloric acid to form a definite "solution compound" represented by the formula $2HCl, H^2O^2$.

The chemical composition of the products of the change at the ends of the first and second periods were ascertained by means of the voltaic balance and ordinary chemical analysis. During the first period forty consecutive measurements of the voltaic energy

* Abstract read before the Royal Society, June 20, 1889.

Digitized by Google

at stated intervals of time were made, and the energy diminished from about 1,219 millions to 2·9 millions; and during the second period eight such measurements were made, and the energy increased to 9·3 millions. A curve is given showing the rate of loss of energy during the first period.

It is interesting to observe that suitably decomposed chlorine water, or probably in its stead a mixture of $6HClO + HClO + HClO^3$ in a proper proportion of water, has the property of absorbing energy by exposure to light, very much like that possessed by the green leaves of plants.

THE PAGET ALTERNATE-CURRENT TRANSFORMER.*

In order to overcome the difficulty of unequal efficiencies at different loads, Dr. Leonard Paget has recently designed a type of transformer which adapts itself to conditions existing in the

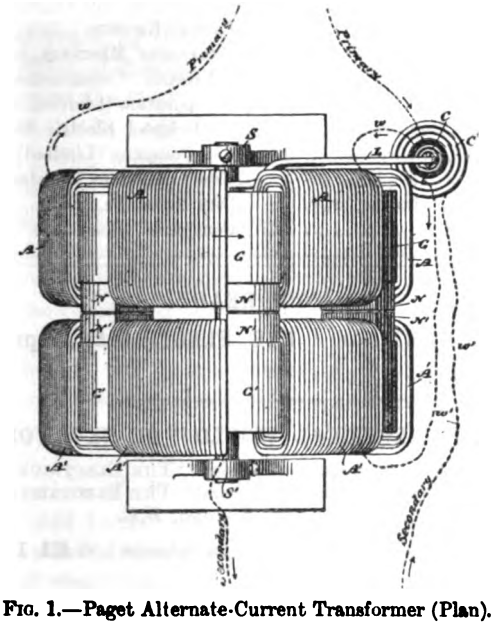


FIG. 1.—Paget Alternate-Current Transformer (Plan).

secondary circuit—that is to say, a transformer which causes the amount of energy utilised in the primary circuit to bear a fixed proportion to the amount of energy required in the secondary circuit in which the lamps are situated, and he accomplishes his object by varying the magnetic circuit in accordance with the load on the

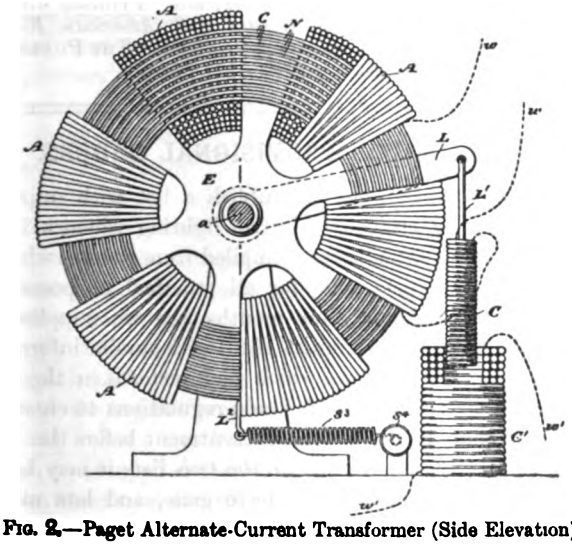


FIG. 2.—Paget Alternate-Current Transformer (Side Elevation).

converter. The accompanying engravings (Figs. 1 and 2) show one form of this new type of converter, Fig. 1 being a plan view showing the circuit connections of the primary and secondary circuits, and Fig. 2 being a side elevation.

As will be seen, the converter is mounted upon two standards, S S′, by means of an iron shaft. Mounted upon the shaft are two iron spiders, which carry a pair of converter coils, A A′, the former, A, constituting a set of primary coils wound in series about the laminated cores G, and made of long, thin strips of iron having projecting teeth, N N′, which constitute the poles of the respective coils, and between which teeth are wound in series on each core the coils A A′. The arrangement is such that when the coils are wound in position the projecting teeth N N fill the space between the coils on one side and N′ N′ between those on the other side. The secondary coils A′ A′ are rigidly fixed upon the axis by a set screw, which passes through the hub, while the primary coils A A are free to rotate upon the axis *a*, and have a lever, L, connected to the hub for producing the rotation. This lever L has connected to its free end a solenoid, C, located directly in the primary circuit and in series with the coils A, as shown. An additional solenoid, C′, is located in the secondary circuit and surrounds the first-named solenoid. The spiral spring, s^3, attached by the lever L^2 to the rotary primary coils, and by an adjusting screw, s^4, to a fixed standard, is designed to regulate the relative location of the cores of the movable and fixed coils under varying conditions.

With this construction the operation of the converter will become evident. Suppose, for instance, that the screw s^4 is so adjusted that the spring s^3 will hold the coils A in the least effective position when a minimum number of lamps are located in the secondary circuit $w' w'$; then, as the lamps are connected in circuit in the usual manner, the influence of the cores upon each other, together with the additional influence of the solenoids C and C′ upon each other in their respective circuits, will cause the coils A to be rotated in the direction of the arrow shown in Fig. 1. This rotation will continue as lamps are cut in to the circuit until a maximum number is reached for the adjustment of the spring s^3, at which time the poles N N′ will lie directly opposite to each other, as shown in Fig. 1, and the multiple magnetic circuits through the twelve adjacent poles of the primary and secondary coils will assume a position of maximum efficiency. The regulation for intermediate positions, as required by varying numbers of lamps in the secondary circuit, is at once obvious, the magnetic circuits varying in accordance with the regulation indicated.

With the construction and principle explained above it is claimed that the efficiency of the transformer is uniformly high for all loads.

* From the *Electrical World*.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-day) FRIDAY, December 6th.

PHYSICAL SOCIETY.

5 p.m. Ordinary Meeting. Papers to be read:—"The Electrification of a Steam Jet," by SHELFORD BIDWELL, F.R.S.; "Notes on Geometrical Optics," by Prof. S. P. THOMPSON, D.Sc.; "On the Behaviour of Steel under Mechanical Stress," by C. H. CARAS-WILSON; "On a Carbon Point in a Blake Telephone Transmitter," by F. B. HAWES.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Students' Meeting. Paper to be read, "Electric Traction." By A. E. CHILDS, Stud.Inst.C.E.

MONDAY, December 9th.

LONDON INSTITUTION.

5 p.m. Lecture: "English Spelling and Pronunciation." By Rev. Prof. SKEAT, Litt.D.

SOCIETY OF ARTS.

8 p.m. CANTOR LECTURE I. 3. "Modern Developments of Bread-Making." By WILLIAM JAGO.

TUESDAY, December 10th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be read, "On the Triple-Expansion Engines and Engine Trials at the Owen's College, Manchester." By Prof. OSBORNE REYNOLDS, F.R.S., M.Inst.C.E.

ROYAL VICTORIA HALL.

8:30 p.m. Lecture: "A Visit to the Banks of the Rhine." By A. HILLIARD ATTERIDGE.

WEDNESDAY, December 11th.

ROYAL MICROSCOPICAL SOCIETY.

8 p.m. Ordinary Meeting. Paper to be read, "The Freshwater Algæ and Schizophyceæ of Hampshire and Devon." By A. W. BENNETT.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. "The Paris Exhibition." By H. TRUEMAN WOOD, M.A.

THURSDAY, December 12th.

LONDON INSTITUTION.

6 p.m. Lecture: "The Science of Animal Locomotion in its Relation to Design in Art." By EADWEARD MUYBRIDGE.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Annual General Meeting. Adjourned Discussion on the Paper on "Electrical Engineering in America." By G. L. ADDENBROOKE, Associate. Election of Council and Officers for 1890.

Digitized by Google

The Electrician.

Published every Friday. Price Fourpence; Post Free, Fourpence Halfpenny.
Editorial, Publishing and Printing Offices:

No. 1, SALISBURY COURT, FLEET STREET, LONDON, E.C.

Telephone No. 2714. Telegrams: "Electrician Newspaper, London."

All Communications to be addressed to "The Electrician," *1, Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "The Electrician."

All letters intended for insertion in "The Electrician," *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

"The Electrician" *is published every Friday morning, in time for the morning mails. Subscribers should receive their copies by the first post on Friday morning.*

"The Electrician" *is on sale at the railway bookstalls throughout the United Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices as above.*

SPECIAL NOTICE.

Owing to the increase in the number of pages of "The Electrician," in order to partly cover the increased postage, we have been compelled to revise the rates for Foreign Subscriptions, which are now as follows:—

	3 months.	6 months.	12 months
For Foreign Parts and Colonies:—	s. d.	s. d.	s. d.
Within Postal Union	6 6	12 6	24 0
Aden, Borneo, Ceylon, China, India, Japan, Java, Labuan, Mozambique, New Caledonia, Persia, Philippine Islands, Siam, Transvaal, and Zanzibar	7 6	14 6	28 0
The rates for the United Kingdom remain as follows:—	5 0	10 0	19 6

TO ADVERTISERS.

"The Electrician" *offers exceptional advantages to Advertisers.* **It has the largest circulation of any English Electrical paper, and circulates all over the World.**

Particulars relating to Advertisements will be promptly forwarded on application to the office.

Trade Advertisements *intended for the current issue must be handed in not later than First Post on Thursday morning.*

Small Prepaid Advertisements *(for Rates see page xv.) are accepted up to 4:30 p.m. on Thursday.*

TECHNICAL PRINTING.

"The Electrician" Printing and Publishing Company (Limited) *beg to inform Electricians, Electric Light Engineers, &c., that they make a specialty of Technical Printing, and have a Staff thoroughly acquainted with Electro-Technology. They can, therefore, promise Accuracy and Despatch in the Printing of Electrical Catalogues and Electro-Technical Literature generally.*

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.

Royal 8vo.

Early in each year is issued "The Electrician" Electrical Trades' Directory and Handbook. *The Directory was established in 1883, and the 1889 Edition, which is now on sale, consists of more than 600 pages of printed matter. Every care is taken to make the names and addresses of all persons engaged in the Electrical Industries absolutely accurate. Useful Tables and Electrical Formulæ are given, together with popularly-written Biographical Notices of the leading Electricians, Electrical Engineers, &c., accompanied in many cases by Portraits.*

The issue for 1890, which will be still further enlarged and improved, is in active preparation. New Names and Addresses, Corrections, Advertisements, &c., should be forwarded at once to the Publishing Office, **1,** *Salisbury-court, Fleet-street, London, E.C.*

CONTENTS OF THE CURRENT NUMBER.

Notes 105
Reviews 110
The Oulton-Edmondson Electricity Meter. Illustrated ... 111
On the Distribution of Electric Energy by Means of Constant Current. By Alexander Bernstein. Illustrated. Concluded 112
Rate of Decomposition of Chlorine Water by Light. By Dr. G. Gore, F.R.S. 114
The Paget Alternate-Current Transformer. Illustrated ... 115
Meetings of Scientific Societies. 115
The Race for Provisional Orders 116
Electric Lighting Notices 117
Electric Traction Notices 120
The Institution of Electrical Engineers—
"Electrical Engineering in America" 120
A New View of Telephone Induction. By John J. Carby. Illustrated 122
The Gilbert Club 124
The Central London Electric Railway 124
American Notes 124
Vienna Notes 125
Scandinavian Notes 126
Correspondence—
Electric Tanning Patents.—L. A. Groth 126
The Silvertown Strike.—Wm. J. Tyler 126
The Manufacture of Ozone. John C. Lawson 126
Trade Notes and Notices 127
Fairbairn and Rawson's Patent Sight-Feed Lubricator. Illus. 127
Patent Record 127
Companies' Meetings, &c.—
Electric Construction Corporation (Limited) 128
Blackpool Electric Tramway Company (Limited) 129
New Companies Registered ... 129
City Notes, &c. 129
Companies' Share List 130

NOW READY.

Volume XXIII. of "THE ELECTRICIAN," price 12/6, post free, 13/6.

"THE ELECTRICAL WORLD" OF NEW YORK.

Arrangements have been made by which "The Electrical World" of New York *can be obtained from* "The Electrician" *Office, 1, Salisbury-court, Fleet-street, London, E.C.*

The Rate of Subscription (payable in advance), is **£1 1s. 0d.** *per annum.*

Single Copies of "The Electrical World" *can also be obtained,* **price 6d. each; post free, 8d.**

"The Electrician" *can also be obtained of the* W. J. Johnston Company (Limited), "The Electrical World" *Office, Times Building, New York, U.S.A.*

Subscriptions are received by "The Electrician" *Printing and Publishing Company for all Continental and American Electrical Journals. Subscription Rates on application to* "The Publisher." *Remittance must accompany order* in all cases.

THE RACE FOR PROVISIONAL ORDERS.

We are this week able to publish a list with important details relating to projected electric lighting schemes in provincial and metropolitan areas, compiled from sources which we believe to be authentic, and, for all practical purposes, sufficiently accurate. About four months ago we supplied our readers (*The Electrician*, August 16th) with similar information with regard to the schemes which had just taken the initial step required by the Board of Trade regulations to entitle the promoters to share in the general presentment before the Parliament of 1890. By comparison of the two lists it may be seen how far the original applicants have gone, and how many of them have dropped out of the running altogether. From the names of the remaining companies it may be gathered also what are their probable prospects of surviving the test of a Board of Trade examination and the final ordeal of a Parliamentary discussion. Further, the amount of competition on the part of the Local Authorities may be estimated from the particulars given in this week's list, which, in these and many other respects, afford material for a very curious and instructive study.

Digitized by Google

To make the situation clearer, it may be well to state once more what are the conditions under which all these various applications for Provisional Orders have been made. First, it was required of intending applicants that the Local Authorities of the towns affected should be notified not later than July 1st; and it was the acceptances of this preliminary condition that we published in August last. The total number of notices was 474. Our comments on the general character of many of these projects at the time seem to have been borne out by what has followed, for we find, after making due allowance for the fact that in many instances several notices are covered by one Provisional Order, certainly not more than 50 per cent. of them have taken the trouble to testify to their sincerity by going a step further. Between July 1st and the end of November a breathing-time was allowed by the Board of Trade, for the applicants, on the one hand, to estimate their individual chances, and for the Authorities, on the other, to safeguard the local interests. In this interval full advertisements had to be made in the local papers and in the *London Gazette*, giving public notice and description of the powers to be applied for; and a copy of these advertisements, accompanied by a map of the district concerned, had to be lodged with the Board of Trade not later than Saturday last. Down to this point our list is completed, and the total number of applications is now shown to be reduced to 179. Three weeks later a formal memorial, signed by the applicants representing the companies or the Local Authorities, with a draft of the Provisional Order applied for, must be in the hands of the Board.

Before the 21st inst., the date on which this third stage will be reached, many difficulties may arise, and the list may be thinned still further; but not materially, we should imagine, as it is probable that those who have gone so far have had plenty of time to consider whether or not they will make the final plunge. This last will be decided in some cases by the action of the Local Authorities, who have almost everywhere adopted an attitude towards the applicants neither friendly nor ingenuous. To frighten off the intruders they have started applications of their own—some fifty in number—and then, when the enemy was out of sight, have tranquilly dropped all further proceedings. In a few instances this ruse has not succeeded, and we are curiously watching to see which of the competitors will stay in the race for another fortnight. In the majority of instances where local opposition is serious, the town gas supply is owned by the Corporation whose anxiety to protect the town property from injurious competition is at least intelligible, and perhaps excusable. Not so where the avowed or ostensible ground of hostility is the creation of fresh monopolies. It is strange that such a misconception should still survive, but the language we see reported at numerous meetings of the local magnates proves that they have yet to learn that the Electric Lighting Act sanctions no monopolies, and that if they come into existence it will be through the neglect or ignorance of the townspeople themselves.

Quite a large number of towns, however, not owning gasworks, have applied for powers to supply electric light either for the streets or for indoor purposes. Some of these seem to be impelled by disputes with local gas companies; and it is possible there may be no other serious motive than to bring them to their knees. But the larger proportion are, so far as our information goes, actuated by the desire to see the electric light made generally useful, and the not unnatural ambition of undertaking the task on their own account, creating in this way a valuable business for the convenience and profit of the inhabitants. It is, no doubt, a grave responsibility for them, and we heartily wish them well through with it. To us, and to the electrical trades generally, it can matter very little who may order the work so long as it is done. That it may be done well is, of course, a great desideratum, for wherever it is done badly discredit to that extent will fall on the electric light. But in the long-run there is as much likelihood of the undertakings being carried out successfully under local auspices as under the direction of a company with inadequate capital and little experience, samples of which are still to be found in our list of applicants to-day. The demand for electrical plant and for electrical experts will be enormously increased in any case; and the genuine residue of undertakings which are certain to go forward after all deductions are made afford a sure prospect of development in electrical industry such as ought to satisfy its most enthusiastic friends.

We have left ourselves no space to comment on the metropolitan notices, which, however, are given with the fulness to which their importance entitles them. But we invite special attention to two supplementary lists of considerable interest—the one relating to notices in respect to electric traction, the other summarising the number of notices served by each of the applicant companies for electric lighting powers. It will be seen that the whole of the 129 notices, exclusive of those served by Local Authorities, come from 49 companies. One group of companies alone appropriates 53 applications; 15 others emanate from one single company, while the remaining 61 are distributed among 36 companies. The electric traction notices speak for themselves: although not very numerous, they are far in excess of any previous year's experience, and the widely-separated localities for which powers are sought indicate that this application of electrical engineering also is making converts in all parts of the country.

ELECTRIC LIGHTING NOTICES.

The following is a complete list of the intended applications for Provisional Orders which have been advertised in the *London Gazette*:—

THE METROPOLIS.

The Metropolitan Electric Supply Company (Limited), of Winchester House, Old Broad-street, notify their intention of applying for a Provisional Order under the Electric Lighting Acts, 1882 and 1888, authorising them to produce, store, and supply electricity for public and private purposes, as defined by these Acts, in the City of London and its liberties, and in the parishes of Paddington, St. John, Hampstead, St. Pancras, St. Mary, Lambeth; St. Mary, Islington; St. James and St. John, Clerkenwell; St. Luke, Middlesex; and St. Mary, Battersea, and so much of the parishes of Clapham, Streatham, Wandsworth, and Putney as is included in the district of the Wandsworth District Board of Works. The Order will contain clauses authorising the Company to construct, &c., on lands belonging to or held on lease by them within the area of supply such central and other stations and works for the generation, &c., of electricity as may from time to time be necessary for supplying electric current, together with all necessary or convenient buildings, engines, &c.; to lay down, maintain, and alter electric lines, &c., for the supply and distribution of electricity and electric currents above or beneath the roads, &c.; empowering them to manufacture, purchase, hire, and supply meters, lamps, appliances, machinery, &c.; to enter into contracts with Local Authorities, companies, and persons in reference to easements and to the supply of electricity and the works required therefor; to empower the Company to make and levy charges for the supply of electricity, and to define and limit the prices to be charged.

The London Electric Supply Corporation (Limited), of 3, Adelphi-terrace, Strand, will apply for a Provisional Order to authorise them to produce, store, supply, and sell electricity, electric current, and other like agency for public and private purposes within the area constituting the City of London and its liberties. The Order will contain clauses empowering the Company to acquire, construct, and use, and from time to time to sell and otherwise dispose of machinery, plant, and apparatus for the production, storage, regulation, measurement, distribution, and supply of electricity. The works proposed to be constructed, used, and maintained are described generally as follows: A central station, or central stations, at which electricity will be generated or collected, and a system of distributing stations and mains by which electricity will be conveyed and distributed from the central station or stations throughout the area of supply. By other clauses in the Order, the Company will ask for authority to acquire,

Digitized by Google

maintain, &c., and to take up, sell, and otherwise dispose of, electric and other mains, storage and other batteries, accumulators, and other apparatus "for transmitting, storing, measuring, regulating, and distributing electricity for lighting and other purposes, public and private, or for converting the same into power, heat, or otherwise, and any pipes, conduits, or other channels of water supply for feed or condensing purposes, or otherwise to be used for the purposes of, or in connection with, the works and lines to be erected, used, or maintained under the Order, beneath or above the streets, &c., in the area of supply." Power will be asked for to make arrangements with Local Authorities and other bodies to rescind and renew contracts for breaking up or otherwise interfering with the streets, and for the supply of electricity; to levy, make, and recover rates, and to authorise the Company and their *employés* to enter upon lands, buildings, or other premises, and to examine any machinery, &c., supplied by the Company, or used in connection with their lines or works. The Company will also apply for a Provisional Order granting them similar powers for supplying electric lighting in St. Pancras, Islington, Shoreditch, Paddington, Bethnal Green, St. Luke, Middlesex; St. George-in-the-East, Mile End, Hampstead, Hammersmith, Fulham, Whitechapel, Hackney, Limehouse, Poplar, Lambeth, Camberwell, and St. George-the-Martyr, Southwark; Wandsworth, Woolwich, Plumstead, Lewisham, West Ham, and East Ham.

The HOUSE-TO-HOUSE ELECTRIC LIGHT SUPPLY COMPANY (LIMITED) will apply for nine Orders, authorising them to produce and supply electricity for public and private purposes,—1, in the City of London; 2, in the parish of Islington and the district of the Hornsey Local Board; 3, in the parishes of Fulham and Hammersmith; 4, in the parish of St. Pancras; 5, in the parish of Lambeth; 6, in the district of the Wandsworth Board of Works; 7, in the parish of Paddington; 8, in the districts of the Acton and the Ealing Local Boards; and 9, in Hampstead, Finchley, Hendon, and Willesden, with powers to acquire lands and to construct works within the various areas of supply mentioned.

Application will also be made to the Board of Trade for Provisional Orders to authorise the LAING, WHARTON, AND DOWN CONSTRUCTION SYNDICATE, LIMITED (or a Company to be formed on their behalf, called the City of London Electric Supply Company, Limited), to produce, store, and supply electricity for public and private purposes, in the whole of the City of London and its liberties, and with powers to acquire lands, to construct works, and to manufacture and supply lamps, meters, and fittings.

Messrs. A. AND S. GATTI will apply for a Provisional Order to supply electricity for public and private purposes in a portion of the parish of St. Martin-in-the-Fields, and in a portion of the area of the Strand District Board of Works. They also notify their intention of applying to Parliament for leave to bring in two Bills to produce and supply electricity for public and private purposes, 1, within the parishes comprised within the Strand District Board of Works; and, 2, within the Parish of St. Martin-in-the-Fields; to acquire land, &c., and patent rights, and licences for using inventions, &c., relative to the production, &c., of electricity, and to manufacture and supply meters, lamps, &c.

The ELECTRIC CONSTRUCTION AND MAINTENANCE COMPANY (LIMITED), of Worcester House, Walbrook, will apply for a Provisional Order to produce, store, supply, sell, and distribute electricity for public and private purposes in certain parts of the districts within the jurisdiction of the Lambeth Vestry, the Vestry of Camberwell, the Lewisham District Board of Works, the Beckenham Local Board, and the Croydon Corporation.

The SOUTH OF ENGLAND HOUSE-TO-HOUSE ELECTRICITY COMPANY, of 15, St. Helen's-place, E.C., propose to apply for an Order to produce, store, sell, and supply electricity for public and private purposes at Richmond, Mortlake, and Barnes.

The MAXIM-WESTON ELECTRIC COMPANY (LIMITED) will apply for a Provisional Order to produce, store, and supply electricity in Ealing, and for that purpose to construct "a central station, at which electricity will be generated from direct-current dynamos, and also by the alternate currents at high tension, to be converted by transformers where necessary, supply electric energy direct to the mains. Electric energy will also be supplied to storage stations where necessary."

Three Provisional Orders will be applied for by the BRUSH ELECTRICAL ENGINEERING COMPANY (LIMITED) to produce, store, and supply electricity, electrical energy and power, 1, within the City of London; 2, within the parishes of Hampstead, St. Leonard, Shoreditch; St. Pancras, St. James and St. John, Clerkenwell; St. Luke, Old-street, St. Marylebone, St. Mary, Islington; and St. Matthew, Bethnal Green; and, 3, within Hammersmith and Fulham; to acquire land, &c.; to erect all necessary stations, &c., and to authorise the Company to manufacture, hire, sell, and let all necessary machines, lamps, accumulators, meters, fittings, &c., required.

Provisional Orders, containing similar powers, will be applied for by the St. James and Pall Mall Electric Light Company (Limited), for the parish of St. James, Westminster; by Messrs. Renshaw, King, and Co., and by the City of Westminster Electrical Syndicate (Limited), for the united parishes of St. Margaret and St. John, Westminster; by the Westminster Electric Supply Corporation (Limited), for parts of the parishes of Paddington and St. Marylebone; by the Chelsea Electricity Supply Company for the parish of St. George, Hanover-square; by the Kensington and Knightsbridge Electric Lighting Company (Limited), for that part of the united parishes of St. Margaret and St. John, Westminster, which is not included in the Kensington and Knightsbridge Electric Lighting Order, 1889, and for the parishes of Paddington, St. Marylebone, and St. George, Hanover-square; and by the Electricity Supply Corporation (Limited), who will apply for two Orders, one for the parish of Paddington, and the other for the St. Giles District Board of Works, and the District of the Strand Board of Works.

PROVINCES.

Town, &c.	Name of Applicants.
Aberdare.....	Western House-to-House Electricity Company.
Aberdeen	Messrs. Norman and Son.
	Scottish House-to-House Electricity Company.
Accrington	The Corporation.
Airdrie	The Corporation.
Ashton-under-Lyne	Municipal Electric Light and Power Corporation (or Company to be formed).
Ayr	The Corporation.
	Messrs. Norman and Son.
Bacup	The Corporation.
Barnsley	The Corporation.
	National Electric Supply Company.
Barrow-in-Furness	Lancashire and Cheshire House-to-House Electricity Company.
Beckenham... ..	Electric Construction and Maintenance Company.
Bedford	The Corporation.
	Midland House-to-House Electricity Company.
Belfast.....	The Corporation.
Birkenhead.....	The Corporation.
Birmingham ...	Birmingham House-to-House Electricity Company.
Blackburn	The Corporation.
Blackpool	The Corporation.
	Lancashire and Cheshire House-to-House Electricity Company.
Bognor	Electric Trust.
Bolton.....	Lancashire and Cheshire House-to-House Electricity Company.
Bootle-cum-Linacre	Lancashire and Cheshire House-to-House Electricity Company.
Bournemouth...	Brush Electrical Engineering Company.
	South of England House-to-House Electricity Company.
Brighton.....	*Brighton and Hove Electric Light Company.
Bristol.....	Brush Electrical Engineering Company.
	Western House-to-House Electricity Company.
Burnley	The Corporation.
Burton-on-Trent	The Corporation.
Bury	The Corporation.
	Lancashire and Cheshire House-to-House Electricity Company.
Cambridge	The Local Authority.
Cardiff.....	Brush Electrical Engineering Company.
	Electric Trust.
	Western House-to-House Electricity Company.
Carlisle	Brush Electrical Engineering Company.
Chadderton ...	The Local Board.
Chatham.....	†Chatham, Rochester, and District Electric Light Co.
Cheltenham ...	The Corporation.
	Brush Electrical Engineering Co.
	Laing, Wharton, and Down Construction Syndicate.
	Midland House-to-House Electricity Company.
Chester	The Corporation.
Coatbridge.....	Scottish House-to-House Electricity Company.
Cockington	Devon and Cornwall Electricity Supply Company.
Compton Gifford	Devon and Cornwall Electricity Supply Company.
Cork	Irish House-to-House Electricity Company.
Coventry.....	Midland House-to-House Electricity Company.
Crompton	The Local Board.
Croydon	Croydon Electric Supply Company.
	Electric Construction and Maintenance Company.
	South of England House-to-House Electricity Company.
Crumpsall	Manchester House-to-House Electricity Company.
Darlington	The Corporation.
	Northern House-to-House Electricity Company.
Derby	The Corporation.
Devonport	Devon and Cornwall Electricity Supply Company.
Dewsbury	National Electric Supply Company.
Dover	The Corporation.
Dundee	The Corporation.
	Brush Electrical Engineering Company.
	Scottish House-to-House Electricity Company.
Eastbourne.....	Eastbourne Electric Light Company.
Edinburgh	Brush Electrical Engineering Company.
	Scottish House-to-House Electricity Company.
Failsworth	Manchester House-to-House Electricity Company.
Fleetwood	The Improvement Commissioners.
Folkestone	Messrs. Crompton and Co. (Licence).
Fulwood	Lancashire and Cheshire House-to-House Electricity Co
Galway	The Corporation.
Gillingham	Chatham, Rochester, and District Electric Light Co.
Glasgow	Brush Electrical Engineering Company.
	Messrs. Muir, Mavor, and Coulson.
	Messrs. Norman and Son.
	Scottish House-to-House Electricity Company.
Gorton	Manchester House-to-House Electricity Company.
Great Yarmouth	The Corporation.
Hampton Wick.	Hampton Wick Local Board.
Hanley	Birmingham House-to-House Electricity Company.

* This application also includes Hove.
† This application also includes Rochester and Gillingham.

Digitized by Google

Town, &c.	Name af Applicants.
Harrogate and Pannal	National Electric Supply Company.
Hastings	Hastings and St. Leonard's-on-Sea Electric Light Co.
Hawick	Scottish House-to-House Electricity Company.
Hove	The Hove Commissioners. Brighton and Hove Electric Lighting Company.
Huddersfield ...	The Corporation.
Hull.....	The Corporation. National Electric Supply Company.
Ipswich	Brush Electrical Engineering Company.
Kelvinside	Kelvinside Electricity Company.
Kingston (Surrey)	*The Corporation. ††South of England House-to-House Electricity Co.
Lancaster	The Corporation.
Leeds	Electric Construction and Maintenance Company. National Electric Supply Company. Yorkshire House-to-House Electricity Company.
Leicester.....	The Corporation. Midland House-to-House Electricity Company.
Levenshulme ...	Manchester House-to-House Electricity Company.
Liverpool	Liverpool House-to-House Electricity Company.
Londonderry ...	Irish House-to-House Electricity Company.
Malvern & Leigh	The Local Board. ‡Midland House-to-House Electricity Company.
Malvern Link...	The Local Board. Midland House-to-House Electricity Company.
Manchester ...	The Corporation. Brush Electrical Engineering Company. Laing, Wharton, and Down Construction Syndicate. §Manchester House-to-House Electricity Company.
Margate & Westgate-on-Sea	Municipal Electric Light and Power Corporation (or Company to be formed).
Morecambe.....	Messrs. Preece and Andrews.
Moss Side	Manchester House-to-House Electricity Company.
Newcastle-upon-Tyne	Northern House-to-House Electricity Company.
Newport, Mon. .	Electric Trust. Western House-to-House Electricity Company.
Northampton...	Northampton Electric Light Company.
Norwich	Brush Electrical Engineering Company.
Nottingham ...	The Corporation. Midland House-to-House Electricity Company.
Oldham	The Corporation. Lancashire and Cheshire House-to-House Electricity Co.
Openshaw	Manchester House-to-House Electricity Company.
Oxford.....	The Corporation. Electric Construction and Maintenance Company. Midland House-to-House Electricity Company.
Paisley	The Corporation.
Partick	Partick, Hillhead, and Maryhill Gas Company.
Plymouth	‖Devon and Cornwall Electricity Supply Company. Electric Trust.
Portsmouth ...	The Corporation. Laing, Wharton, and Down Construction Syndicate. Portsmouth and South Hants Electricity Supply Co.
Preston	**Lancashire and Cheshire House-to-House Electricity Company. National Electric Supply Company.
Ramsgate and Broadstairs...	Municipal Electric Light and Power Corporation (or Company to be formed).
Reading	Brush Electrical Engineering Company. South of England House-to-House Electricity Company.
Richmond (Surrey)..	Brush Electrical Engineering Company. Messrs. Latimer Clark, Muirhead, and Co. ††South of England House-to-House Electricity Co.
Rochdale	Lancashire and Cheshire House-to-House Electricity Company.
Rochester	Chatham and Rochester Electric Lighting Company.
St. Helens	The Corporation.
St. Mary-Church	Devon and Cornwall Electricity Supply Company.
Salford	The Corporation. Manchester House-to-House Electricity Company.
Scarborough ...	Brush Electrical Engineering Company. Electric Construction and Maintenance Company. Yorkshire House-to-House Electricity Company.
Sevenoaks	Electric Trust.
Southampton...	South of England House-to-House Electricity Company.
Stafford	The Corporation.
Stockport	Brush Electrical Engineering Company.
Stonehouse.....	Devon and Cornwall Electricity Supply Company.
Stretford.....	Manchester House-to-House Electricity Company.
Sunderland and Southwick	Sunderland and District Electricity Supply Company.
Surbiton	The Improvement Commissioners. South of England House-to-House Electricity Company.
Tiverton	The Corporation.
Torquay	*Devon and Cornwall Electricity Supply Company. Municipal Electric Light and Power Corporation (or Company to be formed).
Tunbridge Wells	South of England House-to-House Electricity Company.
Tunstall	Electric Trust.
Walsall	The Corporation.
Wednesbury ...	The Corporation.
West Bromwich	The Corporation.
Whitehaven ...	Whitehaven United Gas Company.
Wigan	The Corporation.
Windsor & Eton	Windsor and Eton Electric Light Company.
Withington.....	Manchester House-to-House Electricity Company.
Woking	Woking Electric Supply Company.
Wolverhampton	The Corporation.
Worcester	The Corporation. Midland House-to-House Electricity Company.
Wrexham	Wrexham and District Electric Supply Company.
York	The Corporation. National Electric Supply Company. Yorkshire House-to-House Electricity Company.

* This application also includes one from the Surbiton Improvement Commissioners and one from the Hampton Wick Local Board to light their respective districts.
† This application also includes Surbiton.
‡ This application also includes Malvern Link.
§ This application also includes Salford, Crumpsall, Failsworth, Openshaw, Gorton, Moss Side, Stretford, Withington, and Levenshulme.
‖ This application also includes Devonport, Stonehouse, and Compton Gifford.
**This application also includes Fulwood.
††This application also includes Mortlake and Barnes

The following list shows the number of notices which have been served by each Company individually, as well as those by Local Authorities :—

Name of Company.	No. of Notices Given.
Birmingham House-to-House Electricity Company	2
Brighton and Hove Electric Light Company	1
Brush Electrical Engineering Company	15
Chatham, Rochester and District Electric Light Company	1
Chelsea Electricity Supply Company	1
City of Westminster Electrical Syndicate	1
Crompton and Co., Messrs.	1
Croydon Electric Supply Company	1
Devon and Cornwall Electricity Supply Company	2
Eastbourne Electric Light Company	1
Electric Construction and Maintenance Company	4
Electric Trust	6
Electricity Supply Corporation	2
Gatti, Messrs. A. and S.	1
Hastings and St. Leonard's Electric Light Company	1
House-to-House Electric Light Supply Company	9
Irish House-to-House Electricity Company	2
Kelvinside Electricity Company	1
Kensington and Knightsbridge Electric Lighting Company	1
Laing, Wharton, and Down Construction Syndicate	4
Lancashire and Cheshire House-to-House Electricity Company	8
Latimer Clark, Muirhead, and Co., Messrs.	1
Liverpool House-to-House Electricity Company	1
London Electric Supply Corporation	2
Manchester House-to-House Electricity Company	1
Maxim-Weston Electric Company	1
Metropolitan Electric Supply Company	1
Midland House-to-House Electricity Company	8
Muir, Mavor, and Coulson, Messrs.	1
Municipal Electric Light and Power Corporation (or Companies to be formed)	4
National Electric Supply Company	7
Norman and Son, Messrs.	3
Northampton Electric Light Company	1
Northern House to-House Electricity Company	2
Partick, Hillhead, and Maryhill Gas Company	1
Portsmouth and South Hants Electricity Supply Company	1
Preece and Andrews, Messrs.	1
Renshaw, King, and Co., Messrs.	1
St. James's and Pall Mall Electric Light Company	1
Scottish House-to-House Electricity Company	6
South of England House-to-House Electricity Company	7
Sunderland and District Electricity Supply Company	1
Western House-to-House Electricity Supply Company	4
Westminster Electric Supply Corporation	1
Whitehaven United Gas Company	1
Windsor and Eton Electric Light Company	1
Woking Electric Supply Company	1
Wrexham and District Electric Supply Company	1
Yorkshire House-to-House Electricity Company	3
	129
Local Authorities	50
	179

* The application also includes St. Mary-Church and Cockington.

Digitized by Google

ELECTRIC TRACTION NOTICES.

The following is a list of Companies proposing to obtain powers to employ electric traction :—

THE METROPOLIS.

Applicant.	Powers sought.
Central London Railway (Company to be formed).	To make and maintain underground railways or subways from Bayswater to the City, and to use electricity or other mechanical power (other than steam locomotives).
City & North of London Railway (Company to be formed).	To make and maintain underground railways or subways from the City of London to Islington ; and to use as motive power electricity, or any other mechanical power (other than steam locomotives).
City of London and Southwark Subway Co. (Limited).	To extend existing line from Stockwell to Clapham, and to use electricity or any other motive power (not being steam locomotive engines).
Kensington and Paddington (Subway) Railway (Company to be formed).	To make and maintain a (subway) railway from South Kensington and Paddington, and to use electricity as motive power.
Lea Bridge, Leyton, and Walthamstow Tramways Company.	To construct, maintain, work, and use a tramway, and to employ animal power and any electrical or other mechanical power, except steam locomotives.
London Central (Subway) Railway (Company to be formed).	To make and maintain a (subway) railway from Tottenham-court-road to Shepherd's Bush Common, and to use electricity as motive power.
London Tramways Company (Limited).	To construct and maintain a tramway across Westminster-bridge, and to use animal or mechanical (other than steam locomotive) power for moving carriages.
New Cross, Lewisham, Brockley, Forest Hill, and District Tramways (Company to be formed).	To use animal power, or any electrical or other mechanical power.
North and South London Subway Railway.	To construct an underground railway from Camden Town to the Elephant and Castle at Newington Butts, and to use electricity, pneumatic, cable, or other suitable power.
North London Suburban Tramways Company, and North London Tramways Company.	Use of steam or other mechanical power in working.
North Metropolitan Tramways Company.	To use on the tramways of the Company electrical or other mechanical power, fixed or movable (other than steam), in substitution of or in addition to animal power ; and to hold and acquire patents and other rights, or licence to use patent rights, in relation to any such mechanical power.

THE PROVINCES.

Aldershot and Farnborough (Hants) Tramways Extension.	To construct and maintain tramways, and to use steam, electricity, or other mechanical or horse-power for haulage of the cars.
Bradford (Yorks.) Corporation.	To lay down, construct, and maintain street tramways, and to authorise and empower the use of steam or other mechanical power, or electricity or cable haulage.
Drypool and Marfleet Steam Tramways Co. (Ltd.) and Hull Street Tramways Co. (Ltd.).	To authorise the Drypool Company to run over and use the tramways of the Hull Company by animal power, and steam, electrical, mechanical, or other power.
Folkestone, Sandgate, and Hythe Tramways Company.	To use animal, mechanical, or electrical power of any description.
Huddersfield Corporation	To construct or purchase tramways to be worked by electrical or mechanical power.
Lynton Railway Co.....	To employ electricity or any like agency, either in addition to, or in substitution for, steam power.
National Rifle Association.	To construct, maintain, and work a tramway on Bisley Common (Surrey), and to use animal, steam, electric, or other power.
Penzance and Newlyn (Cornwall) Tramways (Company to be formed).	To construct, maintain, and work tramways, and to employ cable or other mechanical or electric power.
Plymouth Tramways Company.	To use steam or any mechanical power, or electricity or the cable system.
Pontypridd (Glamorgan) Tramways (Company to be formed).	To make and maintain tramways, and to use animal or mechanical (other than steam) power for moving carriages or trucks.
Warboys and Paddock Drove (Hunts.) Tramway (Company to be formed).	To construct, maintain, use, and work a tramway, and to employ animal, electricity, steam, or other mechanical or motive power.
Wellingborough and District (Northants and Bucks) Tramroads Company (Limited).	To form, lay down, maintain, and use tramroads, and to use steam, electricity (by the overhead system or otherwise), or other mechanical power for moving carriages or trucks thereon, and to provide (if thought fit) that such powers shall not be revocable by the Board of Trade or otherwise.
West Hull Tramways Company.	To purchase part of the tramways of the Hull Street Tramways Company, and to use animal power, and steam, electrical, mechanical, or other power.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

"Electrical Engineering in America."*

BY G. L. ADDENBROOKE, ASSOCIATE.

The last eighteen months or two years in America have been much more characterised by commercial and industrial progress with already existing types of plant and apparatus than by a number of new inventions. Inventive ability seems to have been more concentrated on improving and elaborating already existing inventions than on the evolution of new forms and ideas.

The leading types of machines and apparatus are all well known to you, and have been so fully described and illustrated that to enter into a minute account of them now would only be to traverse old ground. I therefore propose to devote myself this evening to central station, construction, and internal work, and the application of electricity to tramway and other industrial purposes. Finally, I propose to make a few remarks on the tone, policy, and aims of American electrical engineers, and those commercially interested with them in advancing the application of electricity.

My visit to America was not quite of the ordinary character, as I came through on my way from Australia, and consequently had to traverse the whole breadth of the continent before reaching the better known towns on the Eastern Coast. I was thus able to make a general, if rapid, survey of what is going on in the far West and in towns remote from the manufacturing and engineering centres, as well as in New York and some of the larger cities.

Overhead Work.

Throughout the continent, from shore to shore, the main thing that forces itself on the observer is the prevalence of arc lighting. Hardly any what we should call moderate-sized village outside the oil region appears to be without its arc lamps. Arc lamps, when used for public lighting, are usually fixed on poles from 20ft. to 40ft. high, according to the caprice of the parties interested in their erection ; or they are slung from the corners of intersecting streets, in which case they usually hang low down ; or the tower system is adopted. When posts are used, they are of rough pine, never painted, often out of the straight, and warped or bent. If the lamps are fixed, iron spikes are usually driven at intervals on each side of the pole, starting about 8ft. from the ground, and forming a sort of ladder by which to reach the lamp. During my whole journey from San Francisco to New York, I can hardly recollect seeing one ship-shape, neat, and smart-looking post, whether for carrying arc lamps or for any other electrical purpose. Everything has a temporary and expedient look about it which is very offensive to English eyes. Creosoting does not seem to be practised, and the only protection applied to the poles which I saw anywhere, consisted of boards fixed round the base and reaching about six feet high ; but this protection was, I think, only applied to large poles carrying circuits or telephone wires. The lamps themselves are always entirely without ornamentation, and are usually very roughly fixed on the poles. If the globes are not clear glass they are usually only lightly frosted, so that the light glares in one's eyes in all its nakedness. When the lamps are hung over the centre of intersecting streets, four wires are brought down from the corners of the neighbouring houses, the lamp hangs from the centre, and is lowered and raised by a pulley and cord. The wires from which the lamp hangs, the cord, and the leads all festoon about in accordance with the chapter of accidents, and look, as we should think, both slipshod and untidy. The only relief to this state of things is afforded by the towers. These towers are usually erected at the intersection of streets, with the four legs at the four angles of the pavement. They are constructed of exceedingly light ironwork. Tapering gracefully upwards to a great height, they are, at any rate, neat and not

* Paper read before the Institution of Electrical Engineers, November 28, 1889.

Digitized by Google

uninteresting-looking objects in themselves, and certainly form very definite landmarks. Three or four arc lamps hung round the top of one of these towers shed a sufficient light over a great area where the houses are not high. With this method of distribution a 20-light machine can be employed to great effect, especially as in country towns and villages where these towers are chiefly employed the object is rather to make darkness generally visible, if I may so express it, than to provide bright illumination in well-defined places. By using the tower method one's eyes are not dazzled by the brightness of the light, which is so much the case with lamps at a low level. In my own case, I used sometimes at night to get quite an irritated feeling when walking about, if at all tired, from the incessant glaring in one's eyes of naked arc lamps, and the impossibility of finding rest anywhere. I mentioned this effect to two or three Americans, but they did not seem to notice it.

Important, however, as the public lighting is, in the large towns it occupies a comparatively inconspicuous place in comparison with the number of lights used for illuminating stores, saloons, hotels, restaurants, and all sorts of public buildings. Arc lamps are so lavishly used in these places, both inside and out, that the principal streets are often literally a blaze of light. There were, as far as I could ascertain, about 2,000 arc lamps in nightly use in San Francisco, 3,000 in Chicago, and I understood that 3,500 were shut down in New York while I was there, owing to the accidents which had taken place, and of which so many accounts have been published. The majority of the arc lamps used outside are fixed by means of light iron rods projecting from the buildings, though some, of course, are hung. The circuits feeding lamps hung either inside or outside of a building either run direct from the nearest poles on each side of it, thus making an angle over and across the pavement which is very unsightly, or a sort of barrel-shaped glass insulator is used. This insulator has a hole through the centre and a groove round the middle of the outside. The wire coming in one direction is passed through the centre of the insulator, turned back on itself, and made off; the wire in the other direction is passed round the outside, and also made off on itself; the two ends of the loop are then carried to the lamp, through which the circuit is completed. Nearly all the wire I saw was insulated with "underwriters' insulation." Where lamps are used internally, this is often carried through wooden window-frames and such other like places without any further protection or care. Once inside, the wire is carried along ceilings and walls quite exposed, but separated about 3in. by small wooden cleats. Sometimes instead of cleats small white porcelain insulators are used. As far as I could learn, it is the invariable custom for all companies to run, fix up, and entirely look after the lamps they operate. The customer simply pays a rent for the use of the lighted lamp of so much a week, month, or year, as the case may be, and has no further trouble of any sort. The rates differ according to the time the lamps are to be in use each night. To see that the lamps burn properly, linemen promenade the streets all night, and are supposed to see every lamp on their circuits at certain intervals.

The circuits themselves are almost invariably carried on poles erected along the edge of the kerbstones. A fair estimate of the average height of these posts is, I think, about 30ft.; of course some are much more, and many less. Long wooden cross-arms are fixed near the top of the poles, carrying from two to six, and even eight, insulators on each arm. These arms are not so strong as we should make them for the purpose. Owing to the length of the arms, and to their not being very securely fixed to the poles, the weight of the circuits often pulls them out of the horizontal. To see a warped and bent pole, set crookedly in the ground, and with the arms at various angles with each other, and the wires on it all hanging in different curves, seems about as dismal and woe-begone a piece of engineering as can well be imagined. I must make some exception, however, in the case of the Thomson-Houston Company, in New York, who at any rate, had got light iron stays attached to the poles and arms, at an angle so as to give more support to the arms, and keep them in their places. The insulators are supported on the arms by wooden pegs, which have a screw-thread cut on the part that projects. On this one of the ordinary green glass insulators is screwed. Green glass insulators are used for every purpose in America, whether for electric light, telegraphs, or telephones. They are very cheap, and answer the purpose well. Still, the effect of green glass insulators on arms painted a dull red, fixed on bare poles from which the bark has just been stripped, is not æsthetic. The majority of the poles for circuits have no steps provided for ascending them. On the frequent occasions when it is necessary to go up to the top to make alterations or add new circuits, the linemen use climbing-irons. The tearing of the wood by the spikes of these climbing-irons gives the poles a jagged and frayed-out appearance from top to bottom. One could fancy they lead to the habitation of some immense squirrel.

The Americans nearly always use solid wire for running their circuits, covered, as I have mentioned already, with underwriters' insulation. Little trouble is taken to keep the various circuits on one pole in regulation with each other, as long as they do not touch. Indeed, the whole construction of the poles and arms is so flimsy that no great strain could be put on the wires. The poles themselves are fixed at short intervals, often not more than 30 yards apart, and seldom above 60. The circuits are rather hung up on the poles than run, in the sense an English lineman attaches to the word. Separate suspenders I never saw used, except for telephone cables. For alternating incandescent circuits of 1,000 volts several separate cables of small size are also used, instead of running a large one with suspenders, as has been the custom here.

What I have just said about short spans for electric light work also applies to telephone and telegraphic work: the spans used in this work are generally also short. In the latter case, since the wires are light, they are run pretty taut without putting much strain on the arms, so that there is not much sag. Wires run in this way are of course not so liable to sway about as long spans are in high winds, and make intermittent contact or get overlapped. Further, the wires, being run along the streets, are protected from high winds in a great measure, and are not particularly exposed to them, as our over-house work is. This method of erection, therefore, rough as it is, and notwithstanding the enormous number of wires which are often suspended from one pole, gives an immunity from contacts and accidents that an English engineer at first can hardly understand and appreciate.

For leading in wires into houses, or for putting on extra wires on a pole—in fact, for general purposes of the sort—a block of wood is used, the lower end of which is cut off at an acute angle, the upper being cut away and turned down, and a screw-thread cut on it to carry an insulator. When the face of the angle is fixed against the side of a house or a pole, and a spike or screw put through it, the insulator projects somewhat, and forms a support for making off the wire. The whole thing is of the cheapest description, but, nevertheless, seems to answer its purpose. Wires are led in from the outside with much less care than is generally used in England; and this applies also to telephone and telegraph work. It often puzzled me how they worked at all after they had been put up a few months. But the fact that the climate is much drier, and fine rain not so frequent as here, has no doubt a great deal to do with it. In the case of arc light circuits entering and coming out of houses, and worked in series—as they always are—it is, of course, a material point that although the difference of potential between the circuit and the earth may be 3,000 volts, yet the difference between the outgoing and incoming wire is only some 50 volts; so that the tendency of the current to break across the leads is really small. Again, the chance of the current going to earth on dry ceilings and walls is, when one comes to look into it, not great. Thus, notwithstanding the rough character of most American work, and the poor insulation of the wires, in this class of work there is a greater freedom from faults and a higher margin of safety than one would at first imagine. The only place where the margin of safety is really low is where the wires enter buildings.

I have now, I think, gone over all the main points in arc lighting construction work. Construction work for alternating currents is generally carried out on much the same lines as for arc-lighting; the only difference is that in the latter case converters are stuck against the outside of buildings instead of arc lamps, which, of course, are in parallel instead of in series. A rough hole is knocked through the brickwork just under the place where the converter is fixed, for the secondary leads, which are slipped through a couple of rubber tubes and carried inside. But little attempt is usually made to execute this part of the work in what we should call a neat or workmanlike manner.

Let us now make a *resumé* of this branch of the subject. There are in America now, I believe, more than a quarter of a million arc lamps in constant use. In the large towns these arc lamps are fed by machines equal to keeping going 50 or 60 lamps each. Outside a central station, supposing it to be for 1,000 lights, we shall find tall and untidy-looking poles 30 or 40ft. high. At the top these poles will have four or five cross-arms, each carrying six or eight insulators. These poles will be continued along the neighbouring streets at intervals of 30 to 60 yards, according to circumstances. Every here and there a circuit will leave the rest for the side of a neighbouring house, supply one or more lamps, being run in the latter case along the face of the houses, and then return again at the next pole. Or a circuit may jump across the street, supply a lamp or two, and then return again to the nearest pole on the side it first started from. Here and there one or two circuits will leave the main line of poles altogether, and turn up a side street: in this case the poles in the side streets are generally smaller. It is surprising the length some of the arc circuits extend in this way—not unfrequently over a dozen miles. As all the machines in a station are usually of the same size, and are run at the same speed, when the circuit is long the number of lamps fed off a nominal 60-light machine may perhaps have to be reduced to 45 to allow for the resistance of the leads. As you are aware, some of these arc machines are now used on power circuits in the daytime, which forms a very welcome source of extra revenue. I trust I have not wearied you by a too minute descrip-

Digitized by Google

tion of this, a not very interesting part of electrical engineering in America; but I was anxious to convey as clearly as I could on what a remarkably simple and crude basis almost the whole fabric of American electrical engineering in this particular at present rests. For I think I am not overstating facts in saying that at least nine-tenths of all the electrical work in America—putting aside isolated plants—is carried out, as far as the construction work is concerned, in the manner I have described. In all this portion of the work I saw next to nothing which showed particular ingenuity, skill, or brilliancy of idea. Simple and crude means were everywhere used to effect in a rough and crude manner the end desired. In the means employed there is little to excite either admiration or interest. The interest lies in the fact that in such a simple and elementary manner so much has been done.

(To be continued.)

A NEW VIEW OF TELEPHONE INDUCTION.*

BY JOHN J. CARBY.

One of the most peculiar developments connected with the introduction of the telephone was the presence of remarkable sounds which were heard when the telephone line was of any considerable length. Sometimes it sounded as though myriads of birds flew twittering by; again, sounds like the rustling of leaves and the croaking of frogs could plainly be heard; at other times the noise resembled the hissing of steam and the boiling of water. Even a display of Aurora Borealis causes powerful currents in the telephone. At one time, I think it was in 1882, during the prevalence of sun spots and after the appearance of a comet, the auroral current became so strong on a line from Boston to Brockton as to operate a miniature arc light which I improvised out of a pair of lead pencil carbons and connected into the line. Some of these disturbances have been more or less satisfactorily accounted for by assuming differences of potential at the two ends of the line, by the sudden heating or cooling of the line, and by the passage of electrified bodies of air or clouds. Another very curious effect was observed when the first two telephone wires were run parallel to each other on the same cross-arm for the distance of even a few miles; it was found that, although the insulation of the lines was high, a conversation carried on over one wire could plainly be heard on its neighbour. This overhearing is commonly called "cross-talk." As the number of telephone wires increased, and their bunching together in cables became necessary, it was found that in addition to the cross-talk there was another element of trouble added, which was due to the electrostatic effect of the cable, and caused the voice to be transmitted in an indistinct and muffled manner. This evil exists to such an extent that where cables are used the speaking limit is soon reached. While a study of the strange noises heard in the telephone might be of interest, I shall in this Paper limit myself to the consideration of cross-talk and to the action which takes place when wires are bunched in cables. In the simple case of inductive cross-talk first cited, in which two telephone wires are strung parallel on the same cross-arm, the presence of cross-talk is said to be due to dynamic or current induction; that is, if a current commences to flow in one of the wires from north to south, it will at that instant cause an induced current to flow in the other wire in the opposite direction, from south to north. As the telephone current is constantly changing its direction and strength, this explanation seems to apply, and is the one given in the text-books. This is the kind of induction referred to in the law of Lenz, and applies to induction coils and to parallel wires when the current is of sufficient strength. I shall speak of this hereafter as electro-magnetic induction. To-night I shall describe some experiments which seem to prove that the induction between telephone wires is due to electrostatic rather than to electro-magnetic action.

I will first show a case of electrostatic induction between telephone wires in which there is a neutral point at the centre of the secondary wire, at which point there is no induction, while at the ends marked inductive effects are noticeable.†

In Fig. 1, E F and C D are two well-insulated parallel telephone wires, each 200ft. long, and placed one-eighth of an inch apart. E F is open at one end and connected to ground at the other through a Blake transmitter, L, in the ordinary manner. In front of the Blake transmitter I place a vibrating tuning-fork, which acts on the transmitter in the same manner as the voice, and which produces impulses in the line E F of the same strength as voice currents. At the centre of the line C D we have the telephone Y, and at the extreme ends the telephones X and Z. With the tuning-fork at L in operation, tones are heard at X and Z, but the middle telephone Y is silent. A study of the changes of potential produced in the wire E F by the transmitter will give us an explanation of this phenomenon. As is well known, the telephone current is an alternating one, and the potential of the line E F varies constantly and is changed from positive to negative many times per second. The wire E F being open at E would be at the same potential throughout. It is assumed that at a given instant the height of potential at F would be represented by the dotted line F H; then the potential at E would be represented by the dotted line E G, and the total

FIG. 1.

charge on E F would be represented by the rectangle E G H F. We will assume that this charge is of the minus sign. The existence of this charge on E F pre-supposes the presence of a charge of opposite sign on C D, which would be represented by the rectangle A C D B. Now, suppose the potential on E F becomes zero, owing to the operation of the transmitter, then the whole charge on E F gets to earth at the grounded end of E F, but the charge on C D has two paths to earth, one at C and the other at D. This results in two currents, as shown by the arrows, one flowing to earth through the telephone X and producing sound at X, and the other flowing to earth through the telephone Z and producing sound at Z. No current flows through the telephone Y, and consequently no sound

FIG. 2.

is produced therein. Again, changing the potential of E F causes a corresponding set of currents, but in opposite directions to those first described, meeting in the centre and producing no sound in the centre telephone, but causing the end telephones to give out sounds the same as in the first instance. Inasmuch as the line E F is opened at one end, and therefore has almost an infinite resistance, it is clear that this phenomenon is purely an electrostatic one. In this and the succeeding experiments I have not attempted to give the exact shape of the induced charge, as it would unnecessarily complicate the subject and would not in any way affect the result. As a matter of fact, the dotted line A B should slope off from the centre toward the ends. With the line E F grounded through an

FIG. 3.

ordinary subscriber's line and instrument, the effect is the same as when the line is open, and the neutral point is still found. This is because the telephone current, even when flowing in a closed circuit, is so weak that it is not capable of producing a magnetic field of sufficient strength to affect the neighbouring wire, or the magnetic effect is so small that it is obliterated by the movement of the static charge. For convenience, in some of the succeeding experiments the disturbing wire will be shown open at one end.

If there is no current flowing at the neutral point, opening the wire at that point should have no effect on the telephones located at the end. In Fig. 2, A B is the disturbing wire with the transmitter L arranged as before; K is a key located at the neutral

* Read before the New York Electric Club, November, 1889.

† In explaining an experiment of Mr. Culley before the Society of Telegraph Engineers in 1875, Mr. Preece pointed out that in a certain telegraph line subjected to induction from a neighbouring telegraph line, there was a neutral point. I can find, however, no reference to this in Mr. Preece's book on "The Telephone," and its practical application to telephone induction seems to have been lost sight of.

Digitized by Google

point of C D. With the transmitter L in operation no change is produced in the tones heard at the telephones X and Y by opening and closing the key K. If this induction were electro-magnetic, opening the line C D would prevent current from flowing in any part of the circuit. In Fig. 3 we have another proof of the electrostatic nature of telephone induction. A B is the usual disturbing wire with its transmitter L. C D is the secondary wire with the telephones X and Y located at the ends, as in the previous experiment. By means of the key K the telephone X may be cut in and out of the circuit. With the key open the usual tones are heard at X and Y. Now, if the induced current flowing in the circuit C D is due to electro-magnetic induction, upon short-circuiting the telephone X and thereby reducing the resistance of the circuit C D, the strength of the induced current should be increased and the tone at the telephone Y should be correspondingly louder. But this is not the case, as on closing the key the sound at Y, instead of being increased, entirely disappears. This is because the charge on the wire C D finds an easy path to earth through the key, and such a small portion of the charge goes to earth through the telephone Y, that no audible effect is produced therein.

Fig. 4 shows the disturbing wire A B arranged as before, but the secondary wire, instead of being put to earth at both ends, has its circuit completed by a second wire placed outside of the field of A B. With this arrangement neutral points are found at T and T^1, while the usual disturbances are heard at telephones R and R^1, located at the ends. In this case a movement of the static charge takes place in the metallic circuit, causing at one moment a set of currents starting from T^1 in both directions through the end telephones and meeting at T, and at the next instant the reverse takes place.

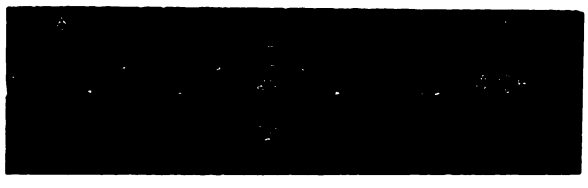


Fig. 4.

I will now show some of the effects of electro-magnetic induction, at the same time suppressing electrostatic induction. In Fig. 5, A B is the disturbing wire as before, but grounded through a short thick wire at A. Instead of placing the tuning-fork in front of the transmitter L and acting on it through the air, producing delicate currents like voice currents, an automatic circuit breaker and five cells of Leclanché battery were connected in the primary circuit of the transmitter, thus producing in the line A B alternating currents of great strength. The secondary wire containing the telephones X, Y and Z is of the same length and at the same distance from the disturbing wire, as in the previous experiments. With the circuit breaker at L in operation, loud musical tones are heard at X, Y and Z, and the tone is the same in all three telephones, the neutral point in this case having disappeared. This is a true case of electro-magnetic induction, because short-circuiting

Fig. 5.

the telephone Y increases the sound in the remaining telephones and leaving the short circuit on Y, and short-circuiting the telephone X still further increases the sound at Z. This latter experiment furnishes a most striking contrast to the result obtained in Fig. 3, where by short-circuiting the telephone X, the sound was completely removed from the telephone at the other end of the line. Another proof that this is electro-magnetic induction is found in the fact that if the line be opened at Y, the sound disappears from all the telephones. If the line A B were opened at A, the potential along the line would be constant, and the charge which A B would take would be represented by the rectangle A G H D, but when the line is grounded at A, through a low resistance, there is, of course, a fall of potential along A B ; the principal drop, however, occurring in the secondary coil of the transmitter L, the line B E representing the height of potential at the terminal of the coil, and the electrostatic effect which the line A B would have is represented by the triangle A E B. This triangle, although exaggerated in the diagram, is still much smaller than the rectangle A G H D, and explains the absence of electrostatic induction between the wires, while the powerful current generated in L, and the comparatively low resistance through which it has to flow, accounts fully for the electro-magnetic effects observed. I have made a large number of laboratory experiments and observations on actual telephone lines, all of which point strongly to the conclusion that electro-magnetic induction does not exist in telephone lines outside of the telephone and transmitter. This view of the subject applied to the theory of transpositions of metallic circuits and to the action of wires in cables gives the only satisfactory explanation of observed phenomena.

Now, we come to the important question : Can this electrostatic induction be prevented ? In answer to this, it may be said that the cross-talk due to electrostatic induction can be eliminated by properly-constructed metallic circuits. But there still remains the muffling effect referred to in the first part of this Paper. This is sometimes called " electrostatic retardation, " and comes in wherever two telephone conductors are run close to each other for any great distance. Where telephone wires are strung upon poles, and are at a distance of a foot or more from each other, this action is very small, but where they are bunched together in cables—a hundred or more within a 2in. pipe—it is very great. It is a curious fact, however, that the amount of this trouble, other things being equal, depends on the character of the insulating medium or dielectric, as it is called, but is independent of its specific insulation resistance, the induction being less when air is used as an insulator than with any other substance among the materials adopted in practice. Dry cotton, paper, and silk rank next to air in this respect, but when gutta-percha or any of the rubber compounds are used, the induction is much greater than with the other materials mentioned. This peculiar property of an insulator, *i.e.*, the facility with which it allows induction to take place through it, is called its " specific inductive capacity." In the present state of the art, then, the only way to overcome electrostatic retardation, after having an insulator or dielectric of the lowest specific inductive capacity, is to increase the distance between telephone conductors. It is evident that in underground systems this distance can never be great. In all of our large city underground systems the space which is allowed for each wire is ·125 of an inch.

This putting wires underground in cities is the only bar to a universal system of telephony, and if direct air lines were built, New York and Chicago would be placed within speaking distance of each other at once. To place telephone wires underground, and maintain the same efficiency as in overhead lines, would require an insulation on each wire of over two feet in thickness, and instead of getting 50 pairs of wires into a 3in. pipe, as at present, a tunnel occupying half the street would be required for one cable alone. When we consider that a telephone office of even moderate size would require about a hundred such gigantic cables, it is seen how almost hopeless the case becomes.

Most engineers think that this difficulty is inherent in the problem, and that the electrostatic action can only be overcome by separating the wires as already stated. In view of the recent researches tending to give us a deeper knowledge of the nature of electricity which have been conducted by Hertz and others, I think there is reason to hope that some other way out of the difficulty may be found. You are all, no doubt, familiar with those celebrated experiments wherein electrical undulations of many million times per second were produced, and, although they were transmitted along a conductor with the velocity of light, yet they followed each other with such rapidity that nodal points were produced, the location of which determined the length of the waves. These waves have been produced in various ways, and by means of large prisms of pitch and by metallic mirrors they have been refracted, focused, and reflected. In fact, they have been found to obey much the same laws as light waves. I think it must follow from these experiments, that our disturbing wire, A B, is throwing off, laterally, waves of great length, and that these waves, impinging upon the adjacent wire C D, produce the various inductive effects observed. Now, if by some means these waves could be deflected from their course and prevented from falling on the wire C D, it follows that there would be no disturbance whatever produced therein. We know that if these waves were of the same length as light waves, this action could be prevented by the interposition of a properly-shaped lens of glass, or by a mirror ; or if they were of the length used in Hertz's experiments, a lens of pitch or a metallic mirror would have the same result. Now, although the telephone waves are of great length, it seems possible that by interposing a properly-shaped dielectric or combination of dielectrics, an interference or refraction might be produced which would have the desired result.

This electrostatic problem is one of the most important, and, until within a year or two, the least studied, and is at present the least understood of all the various difficulties with which we are confronted, and the reward which awaits its proper solution is greater than that which fell to the lot of the inventor of the telephone itself.

Digitized by Google

THE GILBERT CLUB.

On Thursday afternoon last the inaugural meeting of the Gilbert Club took place at the rooms of the Society of Arts. The chair was taken by Sir William Thomson, and among those present were Sir Frederick J. Bramwell, Dr. B. W. Richardson, Prof. D. E. Hughes, Prof. John Perry, Prof. George Forbes, Mr. Latimer Clark, Mr. G. J. Symons, Dr. Atkinson, Mr. H. Trueman Wood, Dr. Laver, Mr. J. Lane, Prof. Silvanus P. Thompson, D.Sc. (Hon. Sec.), and Mr. Conrad W. Cooke (Hon. Sec.).

Prof. SILVANUS THOMPSON explained the objects of the club. What that club proposed to do was to commemorate the tercentenary of William Gilbert, and to do honour to him by reproducing in English the great work which began the science of electricity. Besides the immediate literature of Gilbert himself there was a very large amount of contemporary literature of very great interest to those who studied the early history of the sciences of electricity and magnetism; and it seemed that the Gilbert Club might possibly, in the event of its first work being successful, hereafter reproduce some of those other books. At the same time, it seemed undesirable to commit the club to anything more than the carrying out of the two specific objects, viz., to subscribe the English translation of Gilbert's work, "De Magnete," and form the nucleus of an organisation hereafter for the tercentenary celebration. He concluded by moving the first resolution constituting the Club, which was as follows:—"That the 87 persons who have already signified their acceptance of the invitation to be enrolled among the members of the Gilbert Club be hereby constituted members, together with such others of those who, having already received notice of invitation, shall signify their acceptance thereof before the close of 1889."

Dr. B. W. RICHARDSON seconded the resolution, and said that he did so with special pleasure, inasmuch as he had been an old student of Gilbert, had written a memoir of him, and had lectured on him several times.

The resolution having been carried unanimously,

Mr. CONRAD W. COOKE moved the following:—

"That the objects of the Gilbert Club be as follows:—(1) To produce and issue an English translation of 'De Magnete' in the manner of the folio edition of 1600. (2) To arrange hereafter for the tercentenary celebration of the publication of 'De Magnete' in the year 1900. (3) To promote inquiries into the personal history, life, works, and writings of Dr. Gilbert. (4) To have power after the completion of the English edition of 'De Magnete' to undertake the reproduction of other early works on electricity and magnetism, provided at such date a majority of the members of the Club so desire."

Prof. FORBES seconded the resolution, which was carried unanimously.

After some discussion it was resolved, "That all proposals for membership be referred for the present to the Council, hereafter to be chosen, for selection, up to the number of 200 in all."

Prof. HUGHES proposed, and Sir FREDERICK BRAMWELL seconded the election of Sir William Thomson as president of the club, and the resolution was unanimously carried.

The following vice-presidents were then elected:—Mr. Jonathan Hutchinson (President of the Royal College of Surgeons), Dr. B. W. Richardson, Lord Rayleigh, Dr. Henry Laver, of Colchester, Prof. Reinold, and Prof. Hughes. The following gentlemen were elected to serve on the committee:—Mr. Lant Carpenter, Prof. Ferguson, Sir Philip Magnus, Prof. Rücker, Prof. Foster, and Prof. Forbes. Mr. Latimer Clark was elected treasurer, and Mr. Conrad W. Cooke, Mr. Raphael Meldola, and Prof. Silvanus P. Thompson, hon. secs. The meeting terminated with votes of thanks to the Society of Arts and the Chairman.

THE CENTRAL LONDON ELECTRIC RAILWAY.

The following are some additional particulars with regard to the Subway Railway Scheme, to which we alluded in our last issue:—

Among the many schemes deposited at the Houses of Parliament on the 30th ultimo in which electricity plays so large a part is one for an electric railway, starting from Queen's-road, Bayswater, under Oxford-street, Holborn, Newgate-street, Cheapside, and King William-street, to Arthur-street West, where it is proposed to connect it with the nearly finished City and Southwark Subway, extending to Stockwell.

Although by no means a new idea as regards route, it is novel in its method of attaining its end, inasmuch as the plan sought to be adopted obviates the necessity of in any way interfering, either during construction or afterwards, with the surface of the streets—this, in the view of the promoters, being likely to minimise the great opposition which has hitherto been brought to bear upon previous schemes dealing with these thoroughfares. It is proposed to employ two separate tunnels lined with iron, each of 11ft. in diameter, widening out materially at the different sites proposed for stations. They will be bored in the solid clay, driven under a steel shield (the plan adopted in the subway under the Thames at London Bridge), which it is held will successfully guard against the possibility of any settlements of foundations of property; and, being below the gravel, any risk of danger from water. All the soil excavated it is proposed to bring to the surface at the station sites, which sites will also be used for lowering all the ironwork necessary for the construction of the tunnel. It is not proposed to have any shafts along the route, as the passage of the trains through the tunnel, it is anticipated, will be sufficient to cause a thorough circulation of the air; and as electricity alone will be used both as a motive force for the train and for lighting purposes, the ordinary causes of foul air in underground railways will not exist. The speed proposed to be obtained is 14 to 15 miles an hour. One of the most important of the City stations suggested by the plans is nearly opposite the General Post Office, where a block of buildings now stands facing the entire length of Cheapside; another is to be in the immediate vicinity of the Royal Exchange. At all the stations hydraulic lifts are to be provided (in addition to the ordinary stairways) of very large capacity, and similar in construction and working to those in use at the Mersey Tunnel. The engineers responsible for the scheme are Sir John Fowler, Mr. Benjamin Baker, and Mr. J. H. Greathead, the last-named gentleman having now practically brought to an issue the City and Southwark Subway. Messrs. Ashurst, Morris, Crisp, and Co. are the solicitors for the promoters, whilst Messrs. Sherwood and Co. will have charge of the Bill through Parliament in the ensuing Session.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *November* 23, 1889.

The Overhead Wire Agitation.—As might have been expected, the recent agitation in this city on the subject of overhead wires has been followed by sympathetic agitation all over the country. Thus, at Cincinnati, the Board of Public Works has ordered the electric light wires throughout the city to be buried, and the order now awaits the approval of the Council. In Philadelphia the City Council have taken up the matter, and have elaborated a time schedule, giving the local companies a certain time for the removal of the wires in certain districts, so that at the end of a series of years the whole city should be free from overhead wires. As in most ordinances of the kind, the time allowed is all too short, and it may be taken for granted that the wires will not be underground when the end of the period fixed arrives. In Boston, affairs have taken a somewhat different shape. It being proposed to deal there with the question of overhead wires, the local electric club invited the Mayor of the city, the Fire Commissioners, and other officials to dinner, and then, having dined and wined them, treated them to an interesting discussion on the Municipal regulation and control of electric wires and wiring. A great many views were expressed on the subject by electrical men present, and there can be no doubt that, even if the Mayor were not given a unanimous opinion, he is much better informed as to what electricians think and believe, and is the more likely to act with discretion than if he had simply acted on the spur of the moment and under the impulse of fiery newspaper writing. It has been proposed to establish in Boston some kind of Conduit Commission, and it seems likely that a Board of Supervision will be established. At a meeting of the Common Council just held in that city, the Mayor has been instructed to petition the Legislature for an Act giving the city further control of the erection and maintenance of all electric light wires, with authority to remove dead wires, to require satisfactory insulation, and to regulate the voltage of currents of all classes. It will be seen that the action taken by the Boston electricians in seeking to furnish their chief magistrate with sensible ideas on the subject was an excellent one. It is to be hoped that if a Commission be appointed for Boston such as has been proposed, it will contain men who are informed on the subject and able to grapple with

Digitized by Google

the problems involved. Some idea of the insincerity of the recent clamour in the Press of New York City against electric wires is shown by the manner in which some of the papers which were strongest in their denunciations of the overhead wires have been warmest in their approval of the ordinance granted by the Mayor and Board of Aldermen for the construction of a cable road on Broadway. It is well known to those who have studied the subject that the operation of cable roads has been attended everywhere with a large number of deaths from accidents. The vital statistics of such cities as San Francisco and Chicago reveal deaths from cable railway accidents out of all proportion to the number of deaths from electricity that have occurred in New York City, where, as everybody knows, the conditions have been such as to invite rather than forbid fatalities. Yet, with the long list of accidents elsewhere staring them in the face, the newspapers calmly turn round, and approve the adoption of cable railways for one of the most important and most crowded thoroughfares in New York City. I would not be understood as running cable railways down. They are a great boon in every way, and have done much to educate the public mind up to the idea of traction by motive power other than horses; but when one sees such inconsistency as this on the part of those who have made the lives of New York electricians miserable for the last month or two, it is but timely and proper to utter an energetic protest.

The Ries Method of Securing Continuous from Alternating Currents.—The subject of securing continuous from alternating currents is attracting a great deal of interest and attention in this country at the present time, and the discussion promises to lead on to important results. With regard to the scheme recently proposed by Mr. Nikola Tesla for obtaining such currents without the use of mechanical commutators, Mr. E. E. Ries now comes forward to make some claims on his own behalf. The idea of Mr. Tesla's invention is one in which a continuous opposing or counter-electromotive force or electromagnetic force, or an equivalent active opposing resistance or tendency, is set up against one or both sets of current waves for the purpose of separating and directing them into their respective channels. Such methods, however, Mr. Ries has found to be open to objection so far as their employment for continuous-current work is concerned, for the reason, first, that the currents flowing in the two branches are intermittent or pulsating instead of continuous; and, second, that because of such intermittent flow the reactions set up within the circuit containing the generators of the counter current, if the battery or the magnet or the converter coils proposed are constantly in circuit, will interfere seriously with the satisfactory operation of the system, and be wasteful of energy. This last difficulty Mr. Ries meets and overcomes by the employment of a pulsatory or intermittent counter force, corresponding in periodicity to and by preference derived from the current which it is desired to commutate. In the system which Mr. Ries has developed, however, the various difficulties referred to are preferably avoided by dividing the positive and negative waves from two separate sources of alternating current, the waves of like sign from one source filling in the intervals between the similar waves or impulses from the other in such a way as to produce a practically continuous flow of current over both circuits. Such a form of apparatus devised by Mr. Ries consists of an alternating-current dynamo having two armatures, or a single armature provided with two separate sets of coils, so arranged that one armature or set of coils is half a period in advance of the other. In calling attention to his work, Mr. Ries goes on to develop the idea, and to point out that continuous-line currents can similarly be converted into intermittent pulsations or intermittent current without the employment of mechanical commutators.

New Baxter Motor.—A short while since I noticed in this letter the fact that Mr. Wm. Baxter, jun., was introducing a new type of electric motor, and that he proposed to apply it to street-car propulsion, his idea being to dispense entirely with gearing, placing the motor on the car-axle and driving direct. Mr. Baxter's ideas on the subject have now been further made public, and Mr. Baxter shows his motor applied directly to street-car trucks, or rather the street-car wheels. The motor is located in the back of the car-wheel, covered by a metallic casing, strong enough to hold the entire weight of the car, so that the mechanism is in no way exposed to accidents from shock or collision, and is rendered waterproof. The velocity of the motor is so low that there is no difficulty in keeping the brushes and commutator in perfect order, and Mr. Baxter flatters himself that he is likely to derive great advantage from the whole arrangement. According to Mr. Baxter, the power required to run a car of his new type, dispensing with the gearing, and with an average load of 20 passengers, bears to the power required to run a geared car the proportion of 14,513 to 24,263; or reducing to percentages, the system requires but 60 per cent. of the power used in the geared systems to do the same work.

The Form and Efficiency of Incandescent Lamps.—The Paper read before the American Institute of Electrical Engineers this week on "The Form and Efficiency of Incandescent Lamps," by Mr. Charles J. Reed, embraces a number of points which, though possibly not absolutely new, are well worthy of being pointed out, as many fall into the error which Mr. Reed seeks to correct. If, according to Mr. Reed, we neglect the small amount of heat lost by conduction from the ends of the filament to the conducting wires, and assume that the space surrounding the filament is a perfect vacuum, then the entire energy of the current will be expended in radiation. But this rate of radiation depends only on the elevation of the temperature of the filament above that of the surrounding space and the specific radiating power of the surface at that temperature. He then develops the fact that the square of the current is proportional to the cube of the temperature of the filament for all lamps with constant temperature, and that this relation is independent of the potential, of the length and resistance of the filament, and independent of the candle-power. The final conclusion of Mr. Reed is that the illuminating efficiency of a lamp at any given temperature is constant, and independent of the potential, length, radius, resistance, current, and candle-power of the filament. This means that the energy required to produce a given candle-power will be proportional to the candle-power, and will be the same whether it is expended in driving a large current through a short thick filament or a small current through a long slender filament, provided the temperature or state of incandescence is the same, and provided no heat is lost by conduction from the terminal wires. In the discussion which followed, Prof. Nichols, of Cornell University, corroborated from his own experiments the conclusions reached by the author, and pointed out that comparative experiments in this field were exceedingly difficult, on account of the great difficulty of obtaining lamps in which the vacuum is alike in all. A slight difference in this respect, he showed, would have a very marked influence in the radiating power of the lamp, and hence the temperature reached with a given current.

VIENNA NOTES.

(FROM OUR OWN CORRESPONDENT.)

VIENNA, *December* 2, 1889.

Since October 1st, the trunk line between Vienna and Prague has been in operation, and, as far as traffic is concerned, it has been a decided success. The *average* number of conversations per day has been considerably over 100, counting Sundays and holidays, and the maximum reached has been over 170, whereas on week-days it is generally between 135 and 145. The newspapers use it most extensively, and all the papers in Prague have ordered special tables from the Telephone Company, with telephones arranged on them, so that they can speak, hear, dictate, and write at the same time. Thus, up to midnight, the line is always occupied. As the line is well made, and has very little induction indeed, the service is most satisfactory, and the exchange subscribers in Prague converse with those in Vienna, and *vice versâ*, as easily as in the case of the local service. At present there is only one circuit to Prague. It is a question if with the second circuit, which will have to be added sooner or later, the service will remain as excellent as it is now.

Three circuits are now being run to Budapest from Vienna, and will be ready for public use in a very short time. It will be very interesting to see how far overhearing will disturb the conversation on these lines. To what extent these telephone lines diminish the

Digitized by Google

telegraph revenue is difficult to ascertain, but there can be no doubt that as far as newspaper telegrams are concerned they do so considerably.

The telephonic service for transmitting telegrams from subscribers to the Telegraph Office and *vice versâ* has certainly not suffered so far. In Prague it has increased rapidly since the telephone trunk line was opened. In October, 1888, 3,137 were transmitted from the Telegraph Office to subscribers, and 1,503 from subscribers to the Telegraph Office—total, 4,640. In October, 1889, the figures were respectively 3,595 and 1,945—total, 5,540. This special service is increasing every month in the Telephone Company of Austria's stations. During the first seven months of 1889, 67,116 telegrams were transmitted through their eight exchanges, and the number of their subscribers has now risen to 2,783, with 5,977 kilometres of wire run.

Silicium-bronze wire, 1·25 mm. in diameter, is used in all exchanges in Austria. Many experiments, made by the General Manager of the Telephone Company of Austria, have proved that in using silicium-bronze wire all idea of soldering joints should be given up, and during the last two years no joints have been soldered in the Company's exchanges, with the result that the breakages of wire have decreased to a very large extent. One cannot avoid heating the joint more or less in soldering, and this at once affects the silicium-bronze wire, diminishing its strength by nearly one-half. Instead of soldering, a special joint is made, which gets tighter and tighter the greater the strain, and makes good contact. All experiments now show that the wire never breaks near the joint. This is due to the fact that that part of the wire which is bent to make the joint has practically no strain on it, the wire itself running straight through.

A very pretty and useful tool for telegraph and telephone inspectors and workmen has just been brought out by M. Sedelmaier, of Munich. This tool clears the ends of insulated wire of their insulation, and at the same time scrapes the core.

In electric lighting some activity prevails. The Electricitäts Gesellschaft are building a large Central Station, and Messrs. Siemens and Halske are nearly ready with theirs. The streets are being torn up in all directions, especially in the Mariahilf suburb (the busiest in Vienna), and if the business is at all proportionate to the amount of inconvenience caused, the companies engaged in inaugurating this new departure ought to succeed very well indeed. Evidently the Stock Exchange thinks so, as the Electricitäts Gesellschaft's shares have been run up to a ridiculously high premium. Hitherto, the only large Central Station in good working order has been the splendid one of the Imperial Continental Gas Company, lighting the Opera House and Burg Theatre. The plant and station is large enough to light a large quarter of Vienna, and it seems a pity that the company should rest content with what they have, and do not try to secure their proper share of electric lighting in the city. In Budapest, of course, Messrs. Ganz and Co. reign supreme, so far as electric lighting is concerned, though it is rumoured that the Société d'Installation d'Air Comprimé et de l'Électricité have applied to the Town Council for licence to light a very large part of the town. In Innsbruck Messrs. Ganz and Co. have opened a large station. The power is supplied by the Wurmbach, which has been made to have a fall of 115 metres, giving about 600 horse-power; two turbines of 150 horse-power are used, coupled direct to two dynamos. The primary conductors carry a high-tension current of 2,000 volts to the Central Station, which is about three kilometres outside the town. Transformers are used to convert the high-tension current into one of 100 volts at different places. The mains are overhead outside the town and underground within its boundaries.

Two accidents which recently happened in Temesvar clearly show that the greatest care must be taken with electric light installations. On November 3rd the town was alarmed twice. The first time a report spread that the town-hall was on fire. Though this was happily not the case, yet a fire had broken out in the house of the Chamber of Commerce. The wires in the court of this house became short-circuited, the insulating material melted off, and the wooden cases in which the lines ran caught fire. The fire was extinguished by the fire brigade, the wires being seen to by the engineer of the Brush Company. The second disturbance took place owing to bad contacts, near the cathedral, much in the same manner as the above.

SCANDINAVIAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

COPENHAGEN, *November* 30, 1889.

The Christiania Telephone Company is now in a fair way of getting better accommodation than it has hitherto had, as the alteration of the new house it has bought is commenced. The telephone hall will be enlarged to about twice its present size, and will occupy almost the whole of the second floor, while the first floor will be used for offices, &c., and on the ground floor will be the telephone exchange for the public. The telephone hall will be remarkably well lighted, and altogether fitted out in the best style. The building will have electric light, and will be heated from a central heating apparatus.

The town of Orebro will join the number of Swedish towns which have adopted electric light for the streets. At a recent meeting the Corporation, after much discussion, decided upon this course.

The telephone between Stockholm and Gothenburg continues to give great satisfaction. In Stockholm you can with ease converse with another person at another telephone *viâ* Gothenburg, which is a distance of about 1,000 kilometres.

The Elektriska Aktiebolaget in Stockholm has several provincial central stations in hand similar to the one the Company installed at Vesteras last year. At Arboga the installation comprises 500, and at Ostersund more than 1,000 incandescent lamps. Also at Helsingborg, Sweden, the electric light will shortly be introduced for street lighting.

CORRESPONDENCE.

THE ELECTRIC TANNING PATENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I send you herewith copy of letter received from my solicitor respecting the action "The British Tanning Company *v.* Groth," which is brought to restrain me from working my patent, No. 742 (1888), for tanning with the aid of electricity, as being an infringement of a patented process for producing a similar result, which process was purchased from the patentees, Messrs. Worms and Bale, by the British Tanning Company last spring. I shall feel obliged if you will take note of this matter in your next issue.—Yours, &c., L. A. GROTH.

3, Tokenhouse-buildings, London, E.C., Dec. 3, 1889.

[COPY.]

Fred. Bradley, 75, Mark-lane, London, 29th Nov., 1889.

L. A. Groth, Esq., 3, Tokenhouse-buildings, E.C.

Dear Sir: British Tanning Company (Limited) *v.* Groth. The motion for injunction herein came on for hearing this morning before his Lordship Mr. Justice Sterling, when he declined to make the order as asked, and ordered the motion to come on for hearing at the trial of the action.—Yours faithfully, (Signed) FRED. BRADLEY.

THE SILVERTOWN STRIKE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As incorrect statements continue to appear in some of the daily newspapers with reference to the strike at the India Rubber, Gutta Percha, and Telegraph Company's Silvertown works, we shall be obliged if you will publish the following facts in your columns:—

In consequence of 380 of our workpeople striking, about 900 others, whose work was dependent on steam power, were thrown out of employment. Of this number, and of the original strikers, many have found work elsewhere.

It has been stated that we have lately taken on a few "calendar hands" only; but the fact is, we are glad to say, that as we have been able to provide steam power, about 350 of our old hands have, within the last few days, returned to their employment in our various workshops. Others have applied, and we will take them on as fast as we can arrange work for them.

The number now in our employment at Silvertown is 795. Our wages list for this week amounts to £1,350, most of which will go to alleviate the distress in the neighbourhood, distress which has been caused by the action of the strikers, and prolonged by the misstatements and misleading promises of the agitators.—Yours, &c., WM. J. TYLER, Secretary.

THE MANUFACTURE OF OZONE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to your remarks *re* ozone in your issue of November 22nd, I beg to advise you that I have—and have had for some time—the management of an ozone plant, which turns out daily many thousand cubic feet of this powerful and remarkable gas, and which we could easily increase to an almost unlimited quantity. Unfortunately, the inventor is not in town, being indisposed, or I should be able to obtain his permission to give you more particulars.—Yours, &c.,

JOHN C. LAWSON, Manager.

6, Newman's-row, Lincoln's-inn-fields, W.C., Dec. 3, 1889.

Digitized by Google

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning.*]

PADDINGTON LIGHTING.—The Vestry of Paddington invite applications for the right to light by electricity the Borough of Paddington on and after Tuesday, December 10th. The specification can be seen at the Vestry Hall, Harrow-road, London, W., on and after Tuesday next. Tenders have to be sent in, addressed to Mr. Frank Dethridge by the 16th. Further particulars are given in our advertisement pages.

VACANT APPOINTMENT. — The Barnet Local Board are about appointing a Lighting Inspector. Letters must be addressed to Mr. H. W. Poole, Clerk, Barnet, on or before Tuesday next. Some particulars will be found in our advertisement columns.

SALES BY AUCTION.—We would remind our readers that Wednesday next is the date fixed for the sale by Messrs. Wheatley Kirk, Price, and Goulty, of the plant, loose tools, and effects of the Victoria Engine Works, Chester (at 11 o'clock prompt).—The same firm will sell by auction on Tuesday, the 17th inst., at the North Bridge Electric Works, New Bank, Halifax, Yorks. (at 10 for 11 o'clock prompt), the modern machine tools, new dynamos, cable instruments, plant, patent rights, patterns, stores, stock, and effects of Luther Hanson and Co., Limited (in liquidation). Further particulars of both sales are given in the advertisements on page iii.

MESSRS. PRICE, TALBOT, AND CO. (LIMITED).—This is the title of a firm being established to take over the concern of Dale and Co., Ludgate-hill, E.C. The new firm will undertake the business of electricians, optical and philosophical instrument makers, &c.

THE NETHAM CHEMICAL COMPANY (LIMITED).—We have received a handy box of specimens from this Company. The three bottles enclosed contains samples of (1) crushed first sal ammoniac; (2) refined chloride of ammonium (large crystals), No. 7; (3) refined chloride of ammonium (small crystals), "R.S.," all for use in batteries.

THE GÜLCHER ELECTRIC LIGHT AND POWER COMPANY. — We have received the new illustrated catalogue of this company, which contains full particulars with regard to the dynamos, arc lamps, switches, and electrical accessories manufactured and sold by them. The Gülcher Company has hitherto been associated with the direct-current low-tension system of distribution, but they are now manufacturing high-tension alternate-current plant. In the "Fricker" alternator, which has a stationary armature, special care has been taken to provide for the easy examination and repairs of the armature coils. The "Battersea" transformer is of a compact description, and its ventilation is very thorough.

MESSRS. ERNEST SCOTT AND CO.—This firm's catalogue just to hand contains particulars relating to their dynamos for lighting, depositing, and plating, motors, arc lamps, and general electrical plant and apparatus. It consists of more than 100 8vo. pages, has a full index, is fully illustrated, and is accompanied with a useful price list and code-word for turbine installations.

MESSRS. DAVIS AND SON (DERBY).—We have received from this firm a circular, descriptive of a cheap ceiling rose, made of porcelain. The fuse is enclosed and attached to cover, and has a 1in. break. The springs are brass, and are attached to the base. These springs hold up the cover, and form the contacts. It is claimed for the rose that it is wholly self-contained, and that the weight of the pendant tends to improve the contact.

THE PLANET ENGINEERING COMPANY.—This Company have just fitted up the extensive new premises of Messrs. John Barker and Co., of Kensington, with the electric light. A reception and ball were held on the premises on Monday last, and the ground and first floors of the building were lighted by 42 "Alpha" arc lamps, and the rooms of floors above were lighted by seven Sunbeam and over 60 small incandescent lamps, the current being supplied from the mains of the Kensington and Knightsbridge Company.

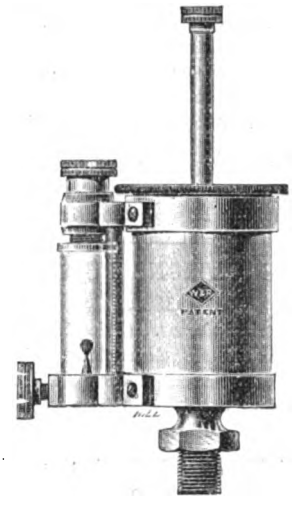
THE TROPICAL AMERICAN TELEPHONE COMPANY (BOSTON).—We are in receipt of a neatly-printed octavo catalogue from this Company, full of practical details for the erection of telephones, bells, &c. The pamphlet, which consists of 50 pages, is full of illustrations, from a call-bell to a multiple switchboard for 3,000 subscribers. This Company owns the patents of Bell and Blake for Central and South America, and the West Indies.

SCIENTIFIC APPLIANCE MANUFACTURING COMPANY (IN LIQUIDATION).—Creditors of this Company are required to send particulars of their claims to Mr. J. A. Hulme, 41, Glen Eldon-road, Streatham, on or before January 15, 1890.

SELF-WINDING AND SYNCHRONISING CLOCK COMPANY (IN LIQUIDATION).—Creditors of this Company must sent in particulars of their claims to Mr. J. D. A. Norris, Suffolk House, Laurence Pountney-hill, Cannon-street, London, E.C., on or before December 28th.

FAIRBURN AND RAWSON'S PATENT SIGHT-FEED LUBRICATOR.

We illustrate herewith the latest form of this well-known lubricator, manufactured by Messrs. Woodhouse and Rawson United (Limited). It is claimed by the patentees that this lubricator possesses all the advantages of other similar lubricators, and that there is no necessity for fixing it to a steam-pipe. It is applicable to any bearing or other working surface. The position of the rod above the cup, as shown, indicates the condition of the supply.



By removing the cover and drawing the piston the supply can be renewed. Regulation is effected by means of an adjustment screw at the lower left side, and any required number of drops can be made to float up through the water contained in the glass tube, from which the oil flows down a metal tube to the stem below. A screw cap above the top bracket allows the tube to be easily filled with water. The lubricator is supplied at a reasonable price, and a large number of them are now in use.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

November 6, 1889.

17,643. C. BROTHERHOOD. Bristol. An improved method by means of electricity of reducing friction in bearings and other parts of machinery.

17,652. J. H. RIDER. Halifax. Improvements in electric arc lamps.

17,675. W. A. HIGGINBOTHAM. Dublin. A new or improved apparatus for governing the electromotive force of dynamo electric machines driven by gas engines and other impulsive engines.

17,694. E. WILSON. London. An electrical Watt meter.

November 7, 1889.

17,754. J. M. SPINK. London. Improvements in conductors of electrical energy.

17,762. F. L. RAWSON and W. WHITE. London. Improvements in electrical switches.

17,763. F. L. RAWSON and W. WHITE. London. Improvements in or applicable to electrical switch-boards and switches.

17,765. H. J. HADDAN. London. Improvements in electro-magnetic dispatch apparatus or portelectrics (J. T. Williams, United States).

17,781. W. WHITE. London. An improvement in electric switches.

November 8, 1889.

17,785. W. SMITH. London. Electric burglar alarm contact-hinge.

17,793. G. J. WEIR and A. WEIR. Glasgow. Improvements in galvanic batteries.

17,819. A. SLATTER and W. RIXON. London. Improvements in switches for making and breaking electric currents.

17,831. J. V. SHERRIN. London. Improvements in electric battery, carbon, and carbon compound elements and their connections.

November 9, 1889.

17,914. W. CLARK. London. Electrically controlled steam steering gear (Sigmund Schuckert and Co., through Wirth and Co., Germany).

November 11, 1889.

17,930. J. H. TUCKER. Birmingham. Improvements in incandescent electric lamps.

17,974. H. H. LAKE. London. Improvements in apparatus for welding by aid of electricity, which improvements are also applicable for other purposes (H. Temp, United States).

Digitized by Google

November 12, 1889.

18,004. R. A. Sloan. Liverpool. Improvements in incandescent electric lamps (G. W. Wilson and C. H. Brown, United States).

18,010. J. A. Timmis. London. Improvements in lamp fittings for electric lighting.

18,018. A. J. Boult. London. Improvements in electro-magnetic brake and traction-increasing system (E. E. Ries and A. H. Henderson, United States).

18,028. E. de Pass. London. Improvements in moulding plates for electric accumulators (La Société Jacquet Frères, France).

18,051. H. H. Lake. London. Improvements in and relating to electric signalling apparatus, chiefly designed for use in hotels and other buildings (F. E. Morgan, United States).

18,067. A. B. Cunningham. London. Improvements in the manufacture of secondary batteries or accumulators.

November 13, 1889.

18,110. J. Farquharson. Acton. Improved winding of armatures of dynamos.

18,112. H. Edmunds (of the Firm of W. T. Glover and Co.). London. Improvements in the metal sheathing of electrical cables.

18,159. C. Weuste. London. Improvements in electric contact apparatus.

SPECIFICATIONS PUBLISHED.

1888.

16,129. Lansard. Electrical alarms. (Price 6d.)

18,233. Taylor. Duplex electric telegraphs. (Price 8d.)

18,525. Wilson. Alternate-current motors. (Price 8d.)

18,589. Huber. Secondary batteries. (Price 8d.)

18,636. Fuller and Fuller. Electrical accumulators. (Price 4d.)

18,659. Siemens Bros. and Co., Limited (Taylor). Electric motors. (Price 8d.)

1889.

1,112. Gwosdeff. Telephony, &c. (Price 6d.)

1,113. Gwosdeff. Telephony. (Price 6d.)

3,556. Firth and Crabtree. Regulating current developed by dynamos. (Price 6d.)

11,705. Englebach and Bright. Preventing loss of surplus electricity generated by dynamos. (Price 8d.)

12,378. Storey. Electric rock drills. (Price 6d.)

12,390. Currie. Electric motors. (Price 8d.)

12,418. Boult (Cobb). Insulating tubing for electric conducting wires. (Price 8d.)

COMPANIES' MEETINGS.

The Electric Construction Corporation (Limited).

An extraordinary general meeting of the Electric Construction Corporation (Limited) was held on Thursday last at the offices, Worcester House, Walbrook, under the presidency of Sir Douglas Fox.

The SECRETARY (Mr. F. Walton) having read the notice convening the meeting,

The CHAIRMAN said: Your Directors are sorry, gentlemen, to have given you the trouble to come here to-day, as we met so recently, but I do not think you will consider the reason of our calling you together unsatisfactory. We have duly applied, as we promised we would, to the Stock Exchange for a quotation of this Company's shares, and you are convened this afternoon for the purpose simply of passing some very formal resolutions to meet the requirements of the Committee of the Stock Exchange. That is the whole business before us to-day, but, at the same time, I think, as we have the opportunity of meeting you, it may be interesting to you to know that since we last met all the purchases of the properties comprising this Corporation have been completed, that the general business of the Company is proceeding in a manner thoroughly satisfactory to your Directors, and that it shows every sign of realising to the full the expectations which we formed in regard to it. Having said that much, I will now proceed with the formal business of the meeting. I move, therefore,

"That the Articles of Association be amended, except as to Article 8 (which is the second in the list), in accordance with the terms of the notice convening this meeting, dated November 19, 1889, as follows:—

(1) "'That Article 8 of the Articles of Association of the Company be amended by inserting after the word "place" in the first line thereof the words "in the United Kingdom."

(2) "'That the following Article be added after Article 8:—8A. "No part of the funds of the Company shall be employed by the Directors of the Company in the purchase of the Company's shares."

(3) "'That Article 19 be amended by inserting after the word "shares" in the second line thereof the words "not fully paid."

(4) "'That Article 25 be amended by adding at the end of the Article the words, "no call shall exceed one-fourth of the nominal amount of a share, and two months at least shall intervene between the time appointed for the payment of one call and that appointed for the payment of the next succeeding call (if any)."

(5) "'That Article 31 be amended by omitting from the seventh, eighth, and ninth lines thereof the words "or regulated by the amount of dividends from time to time to be paid by the Company, or its not divisible profits."

(6) "'That Article 35 be amended by omitting from the fifth line thereof the words "whether fully paid up or not," and inserting in lieu thereof the words "not fully paid up."

(7) "'That Article 88 be amended by omitting the whole of the article, and inserting in lieu thereof the words "The qualification of a Director shall be the holding of shares of the Company of the nominal amount of £1,000. A first Director may act before acquiring his qualification, but shall in any case acquire the same within one month from his appointment, and unless he shall do so he shall be deemed to have agreed to take the said shares from the Company, and the same shall be forthwith allotted to him accordingly."

(8) "'That Article 105 be amended by inserting after the word "shall" in the seventh line thereof the word "not," and by omitting from the seventh line thereof the words "sit at the Board and," and by inserting in the ninth line thereof the words "in which he is," in lieu of the words "notwithstanding his being," and by omitting from the ninth line thereof the word "therein," and by omitting from the tenth and eleventh lines thereof the words "but he shall not be bound to disclose the extent of his interest."

(9) "'That Article 130 be amended by adding at the end of the article the words "other than the shares of the Company."'"

The CHAIRMAN read the various articles in their amended form, and added that the alterations were all of a purely formal character.

Sir DANIEL COOPER seconded the motion, which was put and carried unanimously.

The CHAIRMAN then moved that Article 8A in the notice be amended as follows:—

"No part of the funds of the Company shall be employed by the Directors of the Company in the purchase, or in loans upon the security, of the Company's shares."

Sir HENRY MANCE seconded the proposition, which was also unanimously agreed to.

PATENT
SILICIUM BRONZE AND SILICIUM COPPER WIRE.
The best for overhead Telephone and Telegraph Lines,
AND ALL ELECTRICAL PURPOSES.
Hard Drawn High Conductivity Copper Wire.
ROLLED AND DRAWN
PHOSPHOR BRONZE.
PHOSPHOR BRONZE
VULCAN PHOSPHOR DURO METAL
PHOSPHOR BRONZE
BEARINGS, BUSHES,
AND OTHER PARTS OF
ELECTRICAL MACHINERY.
SOLE PROPRIETORS of the British, Indian and Colonial Patents,
THE PHOSPHOR BRONZE COMPANY (Limited),
87, Sumner Street, Southwark, London, S.E.
WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

Digitized by Google

The CHAIRMAN thanked the shareholders for their attendance, and said it would be necessary to call another meeting for the purpose of confirming the resolutions.

The proceedings then terminated.

The Blackpool Electric Tramway Company (Limited).

The annual meeting of the shareholders of this Company was held in the Victoria School Room, Tyldesley-road, on the 23rd ult. Mr. R. Horsfall, J.P., presided.

The SECRETARY (Mr. R. Handley) having read the notice convening the meeting,

The CHAIRMAN, in moving the adoption of the report and balance-sheet declaring a dividend of 7 per cent., trusted that the same would meet with their approval. The property and assets were much the same as the previous year, with the exception that they had invested in the New Zealand Bank a sum of £2,000, which bore interest at the rate of 4½ per cent. They would also find the expenditure side of the balance-sheet in a satisfactory state, running, as it did, item for item with last year. With regard to the receipts, they must congratulate themselves upon the good season which had been experienced in Blackpool, and which had enabled the Directors to make out so good a balance-sheet. No doubt some of the shareholders would be surprised at the proposals they made of dealing with the money. They proposed paying a dividend of 7 per cent., placing to reserve and depreciation fund £1,350, which, if they continued to add to year by year, would, if the Corporation at any time took over the workings of the Company, help to make the shares realise their full value. The Company had made a contract with an insurance company to meet any claims resulting from accidents which occurred in connection with the trams, and in the case of a woman who in the early part of the year fell from the top of one of the trams, the insurance company disputed their liability, and in the £1,350 they had included a sum of money which could be utilised in case the verdict went against them. The case had been placed before Mr. Cooper, of Manchester, for arbitration, and he hoped that the insurance company would be held liable, and that that part of the money which had been reserved this year would go back into the pockets of the shareholders next year. They had also put aside a sum of money which would meet any extraordinary demand made upon them through any damage to the line, engines, boilers, or machinery. An inspection of the line had been made that week in several places, and, as far as they could tell, it was in a satisfactory condition. Still they felt they should have this reserve fund, so that next year they would not be called upon to place anything to capital account, or to take anything out of the next year's income. If it was not required, then they would get the benefit of it in the next year's dividend, which would also be further benefited by the £235, the balance carried over to next year. If they could make the property a 7 per cent. paying concern, and also increase the reserve fund year by year, when the 21 years' lease had run out their shares would perhaps realise more than 20s. in the pound. He hoped that all would approve of the policy of the Board in putting the Company on a thoroughly sound basis.

Mr. HOYLE seconded, and the motion that the report and accounts be adopted was carried.

On the motion of Mr. HOYLE, seconded by Mr. DEAN, Messrs. Oddie and Morris were re-elected directors. Mr. J. E. Taylor was also re-elected auditor.

The meeting then terminated.

NEW COMPANIES REGISTERED.

BIRMINGHAM ELECTRIC SUPPLY COMPANY (LIMITED).—Registered by Waterlow Brothers and Layton (Limited), 24 and 25, Birchin-lane, E.C., with a capital of £100,000, in £5 shares. Objects: To purchase, on such terms as may be thought advisable, a transfer of the Birmingham Electric Lighting Order, 1889, and of the rights and powers conferred thereby, and to accept such transfer and to exercise and carry out such rights and powers and to observe and comply with all arrangements or conditions attached to such transfer and with the provisions contained in the said order. To generate, produce, sell, and supply electricity for all purposes. The first subscribers are:—G. Albright, The Elms, Edgbaston; G. Hope Johnstone, 38, Northampton-street, Birmingham; F. W. V. Mitchell, The Birches, Edgbaston; J. F. Albright, C.E., Edgbaston; Sir David Radcliffe, Thurcaston Hall, Cheshire; E. M. Shard, Beech Mount, Edgbaston; F. M. Radcliffe, 9, Dock-street, Liverpool. There shall not be less than three nor more than nine Directors. The first to be appointed by the subscribers. Qualification £500. Remuneration, £350, divisible.

THE LIVERPOOL SILVER AND COPPER COMPANY (LIMITED).—Registered by Burton and Co., 37, Lincoln's Inn-fields, W.C., with a capital of £50,000, in £10 shares. Object, the carrying on the business of treating by electrical and other processes smelting, refining, converting, reducing or assaying gold, silver, copper or other ores, mattes or regulus and metals, the manufacture of wire sheets and other forms of copper and copper alloy and for such purpose to acquire premises at Widnes, Lancashire.

CITY NOTES, &c.

EASTERN TELEGRAPH COMPANY.—This Company's traffic receipts for the month of November amounted to £60,578, as against £59,862 in the corresponding period of 1888, an increase of £716.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY.—The traffic receipts of this Company for the month of November, 1889, amounted to £44,147, and to £45,234 in the corresponding period of 1888, a decrease of £1,087.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The Directors of this Company have declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, free of income tax, for the quarter ended September 30th last, and payable on the 24th inst. The books of this Company will be closed from the 16th to the 23rd inst., both days inclusive. The traffic receipts of this Company for the week ended November 29th amounted to £5,931.

CUBA SUBMARINE TELEGRAPH COMPANY.—The estimated traffic receipts of this Company for the month of November, 1889, were £3,000, as compared with £3,107 in the corresponding month of last year. The receipts for the month of August, estimated at £2,700, realised £2,815.

DIRECT SPANISH TELEGRAPH COMPANY.—The receipts of this Company for the month of November amounted to £2,497, against £1,950 for the corresponding period of last year, an increase of £547.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic returns of this Company for the month of November amounted to £23,200. From January 1st to November 30th they were £252,400, against, in the corresponding months of 1888 and 1887, £250,200 and £242,880 respectively.

LIVERPOOL SILVER AND COPPER COMPANY.—This Company has been registered to acquire premises at Widnes, in the county of Lancaster, and to carry on the business of treating by electrical and other processes gold, silver, copper, or other ores. Capital, £50,000, in £10 shares.

NATIONAL TELEPHONE COMPANY (LIMITED).—The Directors of this Company have declared an interim dividend, for the six months ended October 31st last, at the rate of 6 per cent. per annum (less income-tax) on the First and Second Preference shares and on the fully-paid ordinary shares of the Company. The transfer books of the Company will be closed till December 17th, and the dividend warrants will be posted on the evening of the 16th inst.

STOCK EXCHANGE.—Application has been made to the Committee to appoint a settling day in, and to grant a quotation to, the Fowler-Waring Cables Company's (Limited) shares.

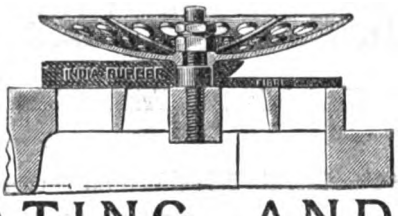
WEST COAST OF AMERICA TELEGRAPH COMPANY.—The traffic receipts of this Company for the month ended November 30th amounted to £6,600.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended November 29th, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £4,259.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The receipts of this Company for the half-month ended November 30th amounted to £3,089, as compared with £2,969 in the corresponding period last year, an increase of £120. Receipts for the month of August, estimated at £4,502 realised £4,529.

NEW VALVE

No Rubber, Percha, or Leather.



One-half the price of Rubber or Metal.

FOR CIRCULATING AND AIR PUMPS.

Unaffected by any Lubricating Oils. Does not Expand in diameter. Feed Water may be worked at any temperature Suitable for any shaped guards. Only one quality manufactured.

"12, John-street, Sunderland, 26th Sept. 1885.

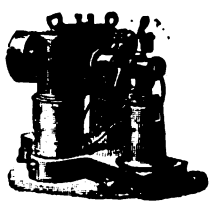
"DEAR SIRS,—In reply to your letter of the 25th inst., the Valves I got from you have done their work well, and ARE AN UNQUALIFIED SUCCESS. I will continue to get them from you as required.—Yours faithfully, JAMES WESTOLL."

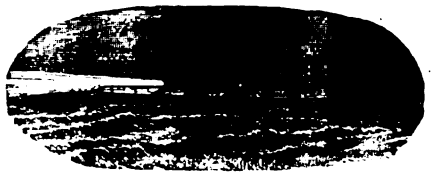
For further Testimony and Prices, apply to **MOSSES & MITCHELL, 68-71, Chiswell Street, London.**

Digitized by Google

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Wednesday, Dec. 4, 1889.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending Dec. 4, 1889.	
£			**TELEGRAPHS.**		£ s. d.		Highest.	Lowest.
1,770,360	Stock	12/6	Anglo-American	51 52	5 5 9	Jan., Apr., July, Oct.	51⅞	50¼
2,614,820	Stock	25/0	Do. Preferred	86 87	6 6 5	,, ,,	87	84½
2,614,820	Stock	...	Do. Deferred	16⅜ 17¼	...	February	17⅛	16⅞
130,000	£10	4/0	Brazilian Submarine	12¼ 12⅜	5 17 8	Mar., June, Oct., Dec.	12⅝	12⅜
112,900	£100	5%	Do. 5 per Cent. Bonds	101 103	4 16 9	January and July	101½	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	106 109	4 11 9	June and December.	...	...
16,000	10	9/0	Cuba Submarine	14¼ 15	6 0 0	February and August	...	...
6,000	10	10/0	Do. Preference 10%	19½ 20½	4 19 9	,, ,,	...	...
12,931	5	2/0	Direct Spanish (£4 paid)	3⅜ 4⅛	3 15 4	March & September	4⅛	4
6,000	5	5/0	Do. Preference 10%	9 10	5 0 0	April and October	9⅞	...
60,710	20	3/6	Direct United States	10 10½	6 13 4	Jan., Apr., July, Oct.	10½	...
380,000	10	2/6	Eastern	13⅞ 14⅛	4 12 0	,, ,,	14⅛	13¾
70,000	10	3/0	Do. 6 per Cent. Preference	15⅛ 15⅜	3 16 2	,, ,,	15⅛	15⅞
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock	106 108	3 14 1	May and November.	107	106½
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	107 110	4 10 11	February & August	...	...
250,000	10	2/6	Eastern Extension	13⅝ 13⅞	4 13 8	Jan., Apr., July, Oct.	13⅞	13⅝
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	102 104	3 16 1	February & August	...	...
473,000	100	5%	Do. 5 per Ct. (Austrln. Gov. Sub.) Debs. 1900	104 107	4 13 6	January and July	...	...
179,177	10	2/0	Globe Telegraph and Trust	8⅜ 9	5 3 9	Jan., Apr., July, Oct.	8⅞	8⅝
178,992	10	3/0	Do. 6 per Cent. Preference	14½ 15	4 0 0	,, ,,	14⅛	14⅜
150,000	10	5/0	Great Northern	15⅜ 16⅛	4 12 4	Jan., July, and April	16⅛	...
17,000	25	12/6	Indo-European	41 43	5 16 3	April and October	...	...
9,000	8	4/0	Reuter's	7 7⅜	5 6 5	April and October	7½	...
15,609	10	5/0	West African Telegraph	9⅛ 10⅛	...	...	9⅛	...
300,000	100	5%	Do. 5 per Cent. Debentures	100 103	4 17 1	March & September	101	...
30,000	10	5/0	West Coast of America	10½ 11	5 0 0	January and July	10⅜	...
150,000	100	8%	Do. Debentures 8%	123 128	6 5 0	June and December	127	...
88,321	10	nil.	West India and Panama	2⅞ 3⅛	...	...	3	2⅞
34,563	10	12/0	Do. 1st Preference 6%	11¼ 11⅝	...	April and October	11⅝	11⅜
4,669	10	10/0	Do. 6 per Cent. 2nd Preference	14½ 15½	...	...	...	...
45,181	15	6/0	Western Brazilian	9¼ 9⅝	7 13 9	May & November	9⅝	9½
$1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	118 122	5 14 9	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	100 102	5 17 2	March & September	102	101
			TELEPHONES.					
224,850	14/0	5%	Consolidated Telephone and Maintenance	⅜ ½	...	Yearly	...	...
220,000	£1	3%	Oriental (11s. paid)	⅛ ⅛	3 15 11	...	...	...
*	*	...	National	5¼ 5⅜	...	...	5⅛	5¼
55,000	5	3/0	United River Plate	4⅞ 5⅛	...	January and July	5⅛	...
			ELECTRIC LIGHT.					
23,692	5	2/0	Anglo-American (fully paid)	...	...	February & August	...	...
79,934	5	6%	Swan United (£3. 10s. paid)	4⅞ 5⅛	4 0 0	...	5	4⅞
500,000	10	...	Metropolitan Electric Supply (£3 paid)	4⅞ 5⅛	...	...	5⅛	...
			MISCELLANEOUS.					
37,350	12	12/0	Telegraph Construction and Maintenance	44 46	5 4 5	March and July	45	44½
41,600	10	10/0	India Rubber, Gutta Percha & Telegraph Works	17½ 18½	5 8 1	February & August	18	17⅞





Before Ordering!

ELECTRICAL PLANT & ACCESSORIES

WRITE FOR THE FOLLOWING PAMPHLETS TO THE

UNITED ELECTRICAL ENGINEERING CO., Ltd.

Head Offices: 3, Princes Mansions, VICTORIA ST., WESTMINSTER.

"ELECTRICAL DISTRIBUTION."—Commercially considered, with Estimates.

"MACHINE DRIVING BY ELECTRICITY."—The Uses of Electro-Motors for Traction and Stationary Purposes.

"THE TELPHER SYSTEM OF CHEAP TRANSPORT," for Minerals, Goods and Passengers.

"ELECTRICAL SUPPLIES."—Prices and Particulars of the most approved Electrical Appliances

ELECTRICAL PLANT ON VIEW.

Digitized by Google

THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 604.—Vol. XXIV. FRIDAY, DECEMBER 13, 1889. Price Fourpence.

NOTES.

Some of our friends have asked us to take up a statement, which appears in the "Medical Battery Company's" advertisement, that someone who is styled "the Assistant Editor of *The Electrician*" has written in favourable terms of Mr. Harness's Electropathic Belt. There is no legal remedy for misstatements of this sort, and we must content ourselves with a simple contradiction.

On another page will be found an abstract of Mr. A. E. Kennelly's report "On the Heating of Conductors by Electric Currents," which was read before the recent Edison Convention, at Niagara Falls. It has long been a matter of common knowledge that the Board of Trade limit of 1,000 amperes to the square inch resulted, if rigorously adhered to, in overheating in the case of large conductors, and gave too great a sectional area to the smaller wires. The exhaustive experiments of Mr. Kennelly on the safe working limit for insulated copper conductors carried in wooden panels resulting, as these experiments have, in what appears to be a trustworthy empirical formula, are, therefore, of the utmost practical value. A sliding scale such as proposed by Mr. Kennelly would certainly seem desirable.

Recurring seasons bring round the usual announcements of public lectures, and electricity claims at least an ample share. At the Royal Institution the Juvenile Christmas Course, begun by Faraday, and continued by Tyndall for so many years, is this year entrusted to the hands of Prof. Rücker, F.R.S., than whom none is certainly more able to carry on the torch of popular science. Prof. Rücker, of course, takes electricity as the subject of his six lectures. We notice that he intends to make special references to the researches of the late Dr. de la Rue.

At the Friday evening "discourses" at the Royal Institution electricity takes an unusually predominant part, no fewer than five of the ten lectures before Easter being on electrical or magnetic topics. These include an account of the "Scientific Work of Joule," by Prof. Dewar; "Problems in the Physics of an Electric Lamp," by Prof. Fleming; Magnetic Phenomena," by Mr. Shelford Bidwell; "Electrical Relations of the Brain and Spinal Cord," by Mr. F. Gotch; and "Electro-Magnetic Radiation," by Prof. Fitzgerald. In addition to this, Lord Rayleigh is to give a course of seven lectures on "Electricity and Magnetism," on Saturday afternoons, beginning in February.

Mr. Shelford Bidwell's neat experiments of the effect of electrification upon a steam-jet—or, rather, on the cloud of water spherules which appear when steam condenses into visibility—won the admiration of all the audience at the Physical Society last Friday. The peculiar and instantaneous increase in opacity at the moment of electrification, Mr. Bidwell suggests as the cause of the sudden darknesses which often occur in thunderstorms. Mr. Bidwell's research, which was conducted quite independently of some German researches on the same line, is well worthy of the attention of meteorologists.

At the same meeting Mr. Bidwell referred to the peculiar behaviour of a gas-flame when placed between the poles of an influence machine. It has long been well known that the flame points away from the positive knob and towards the negative knob. Old readers of this journal will remember a rather acrimonious discussion some years ago in which Mr. J. Johnston insisted on this phenomenon as an absolute proof of the direction in which electricity moves. All it proves is that the flame is itself not at zero potential; but the electric state and behaviour of flames are matters at present wrapped up in much obscurity.

In a very interesting Paper on "The Behaviour of Steel under Mechanical Stress," read at the Physical Society's meeting last Friday, Mr. Caras-Wilson described some experiments recently made by him, the results of which showed that magnetic induction is increased in a steel bar by submitting it to mechanical stress. The effect increases regularly with the stress and is largely permanent. The ratio of the permanent to the temporary effect also increases with the stress until, at a point below that at which the elastic resistance of the steel is overcome, the effect becomes entirely permanent. A comparison between some of Mr. Caras-Wilson's results and those obtained by Dr. Joule on the elongation of steel bars under magnetisation ("Scientific Papers," Vol. I., pages 253-256) showed that similar molecular effects are produced on steel bars by magnetisation, and by mechanical stress; and the author showed that, assuming 13×10^3 tons per square inch as the value of Young's modulus for the soft iron wire employed by Joule, in order to produce a molecular stress of the same

Digitized by Google

amount as that caused by magnetisation, an elongation 200 times as great as that accompanying magnetisation is required.

THE replies to the Edinburgh Exhibition circular recently sent out by the Committee of the Electrical Trades Section were, we hear, by no means numerous, but the terms offered by the Exhibition Committee were generally deemed acceptable.

OUR old friend the mechanical telephone has turned up again as unerringly as the big gooseberry and the sea serpent. This time he comes demanding, we hear, no less than £200,000 for his "patent rights." The great improvement which has apparently been responsible for creating this immensely enhanced value is that the diaphragm which receives the speaker's voice has now been attached to the case by means of certain spiral springs. How far this differs from the "Empire" Telephone, for which five years ago £50,000 was asked, or from the excellent "Stanhope" mechanical telephones, we do not quite understand. But that so vast an improvement should be rewarded by such a paltry sum as £200,000 passes our comprehension.

THE Silvertown strike has, it is said, completely collapsed, the Company having secured the services of fresh men to take the places of the old hands at wages for which the latter refused to work. We are extremely sorry for the strikers, although they have no one to blame but themselves, and if it be the case, as is alleged, that they paid from one-third to one-half their earnings for house rent, it would seem that action should have been taken rather against their landlords than against their employers. Surely, however, that statement must be exaggerated. The wages paid by the Silvertown Company seem to have been rather above the average for their class of workpeople; and to say that they pay half or even a third for living accommodation is simply incredible.

SPEAKING of strikes, it is not improbable that the electric light may profit somewhat by the threatening aspect of affairs in the gas industry. That, however, is not a fact on which we care to dwell with satisfaction, the supply of electricity being no less dependent upon loyal co-operation between workmen and employers than is the manufacture of gas. One thing, however, deserves noting; whatever may come of the present offer of the South Metropolitan Gas Company, permanency of contract between master and man is the only final solution of the great Industrial Problem, and it is one which sooner or later electrical undertakers will have to adopt. On this point, at least, the Gas Company deserve to be supported and imitated.

Apropos of our note last week inviting the ardent photographer to secure an authentic image of St. Elmo's Fire, we have lit upon the following passage in M. W. DE FONVIELLE'S "Thunder and Lightning":—"A photographer of Berlin had taken a negative image of the bronze statue of an Amazon vanquishing a serpent with her lance. On examining the positive proofs he was excessively surprised to see a dark streak standing out from the upper end of the lance." There seems to be some mistake in the description, for surely the streak should appear dark in the negative, not in the print. M. DE FONVIELLE gives, however, no references. Can any of our photographic readers supply us with information?

AMONGST the fancies which grew up around the loadstone in the dark ages, when its power was regarded as a species of black magic, was the notion that if it were ground to powder and dissolved in wine it brought enormous strength to him who drank it. So far as we know, nobody has yet suggested that this is the secret of the power of the rival "strongest men on earth" who are now exhibiting their feats in London. Nor if such a statement were made should we believe it. Yet "steel wine" is recognised by the medical faculty as an excellent tonic. Only, if the magnetic wine were found equally strengthening, its virtue would be attributable to the iron—not to the vanished magnetism.

SAYS the *Western Morning News* in a recent issue, "Quietly, and without much to-do, the electric wires are threading their way beneath the streets in nearly every district in London. . . . But as yet there has not been a single light to show as justification for all this vast expenditure and preparation. One day we shall hear that the last junction has been made, and with the first few revolutions of the dynamos, ten hundred thousand lamps throughout the town will suddenly blaze with light. It will be a pretty and notable sight." Indeed!

AT the Meeting of the Institution of Electrical Engineers last night, the following premiums were awarded by the Council in respect of Papers read during the past twelve months:—The Institution Premium, value £10, to Mr. W. M. MORDEY, for his Paper "On Alternate Current Working"; the Paris Electrical Exhibition Premium, value £5, to Dr. OLIVER LODGE, for his Paper "On Lightning, Lightning Conductors, and Lightning Protectors"; the Fahie Premium, value £5, to Mr. A. E. KENNELLY, for his Paper "On Certain Phenomena connected with Imperfect Earth in Telegraphic Circuits."

The International Telegraph Congress.—The next meeting of this Congress will take place in Paris next May.

The Royal Society.—The following Paper, by Dr. Hopkinson, was down for reading on Thursday, "Magnetic Properties of Alloys of Nickel and Iron."

Municipal Lighting in Germany.—The municipalities of Breslau and Hanover have decided to undertake the erection and operation of municipal central lighting stations.

York.—At the last meeting of the Town Council it was decided to proceed with the application for a Provisional Order. The capital required for lighting the proposed area is estimated at £18,000.

Airdrie.—At the last meeting of the Town Council it was decided to drop for the present the application for an electric lighting Order, and to await further developments of the electric light.

Glasgow.—On the recommendation of the Gas Committee, it was decided at a recent meeting of the Town Council to put down the capital which it was proposed to expend on the electric lighting scheme at £250,000.

Digitized by Google

Bremen.—The local tramway company has decided during the forthcoming Industrial Exhibition to lay down an electric tramway on the Thomson-Houston system, and to light the line by means of 40 or 50 arc lamps.

National Telephone Electrical Society.—At the meeting of this Society on Friday evening last, Mr. William Ollerenshaw read a Paper on "Induction Coils." The subject was illustrated by an interesting series of experiments.

Progress of the Zipernowsky System.—At the present moment 62 central stations on this system, are supplying current to 868 arc lamps and 98,385 incandescent lamps, are in operation on the Continent, principally in France and Italy.

Appointment.—Mr. Sydney T. Dobson, M.I.E.E., late senior assistant engineer on the Vienna Central Station of the Imperial Continental Gas Association, has been appointed chief engineer to the St. James's and Pall Mall Electric Light Company (Limited).

Overhead Wires in Glasgow.—At the last meeting of the Town Council a letter was received from Firemaster Paterson, calling attention to the increasing number of overhead wires. It was decided to appoint a Special Committee to take immediate action in the matter.

The International Ironmongers' Exhibition.—The full title of this Exhibition, which is to be held at the Royal Agricultural Hall on March 17th to 29th next year, is, we are informed, "An International Exhibition of Machinery, Manufactures, Appliances, and Inventions incidental to Engineers, Electricians, Builders, and Ironmongers."

Leamington.—At the last meeting of the Town Council a letter was read from the Midland Electric Light and Power Company, stating that they were prepared to continue the lighting on the terms recently proposed by the Council, and suggesting that 25 and 50 candle-power incandescent lamps should be used in lieu of arc lamps, as desired by the Council.

The Edinburgh Exhibition.—A contract for the arc lighting of the Exhibition has been arranged with the Brush Company. The lighting will be carried out by means of 350 arc lights of 2,000 candle-power. In view of a general desire on the part of foreign exhibitors, as well as of exhibitors in this country, the Executive Council have decided to grant diploma awards in all sections of the Exhibition.

Institution of Electrical Engineers.—The last Students' Meeting of the present session took place on Friday evening last, Mr. Gisbert Kapp in the chair. A Paper was read on "Electric Traction," by Mr. A. E. Childs, the discussion being maintained by the Chairman, Messrs. Barton, Muir, and Poynton. After Mr. Childs' reply a vote of thanks to Mr. Kapp terminated the proceedings.

Electricity at the Ellenborough Colliery.—Messrs. Goolden and Co. are putting in an electric light and power installation at the Ellenborough Colliery. It is proposed to have eighty 16 c.-p., six 50 c.-p., and two 600 c.-p. lamps to light up above and underground. A cable is to be run down the shaft to drive an electric pump and coal cutter. It is expected that the work will be completed in about three weeks.

Johannesburg.—The plant for the central lighting station is to be equal to supplying current to 8,000 16 candle-power incandescent lamps, and 60 500 candle-power arc lamps, with a large balance of motive-power for supplying electric motors, and to allow for additional lights as they may be required. The generating plant is to consist of twelve boilers, each of 100 indicated horse-power, and of five horizontal coupled compound engines of 170 horse-power.

The Municipal Lighting Station at the Halles Centrales.—The lighting of the Halles, according to the *Bulletin de l'Electricité*, does not give entire satisfaction: the lamps are said to be badly arranged and of insufficient candle-power. The Ferranti alternators, moreover, continue to be the subject of complaints from French electrical firms, who assert that the employment of English dynamos at the Halles is directly contrary to the regulations of the Conseil Municipal.

The St. James's and Pall Mall Company.—At a meeting of the Vestry last week a letter was read from a ratepayer, complaining of a nuisance caused by the works of the St. James's and Pall Mall Electric Lighting Company in Mason's-yard. A letter was read from the same Company, stating their intention of applying for a Provisional Order to construct two railways running under Oxford-street, one stopping at Tottenham Court-road, and the other going on to the City.

South Shields.—At the last meeting of the Town Council, the Town Clerk stated that no notice had been given with respect to providing the district with the electric light. It was, he thought, necessary on the part of the Council to give their attention to the matter during the coming year, in order that, before anybody else occupied the ground, the Council might have the opportunity of deciding whether they would secure for the town the right of providing the electric light.

Electrically Illuminated Sights for Night Firing.—The big guns turned out by the Elswick arsenal are now fitted with a device to facilitate firing at night. The ordinary sights are illuminated by a small incandescent lamp, the rays from which, passing through a lens, are converged, so that only a minute point or line of light just sufficient to distinguish the sight is obtained. By means of an adjustable resistance, the light can be modulated to suit the degree of darkness of the night or the eye of the observer.

A New Insulating Material.—A new insulating material for electric conductors has been brought out in Germany. It consists of paper which has been thoroughly soaked in an ammoniacal copper solution. The pasty mass is then pressed against the conducting wires to be covered by means of rollers, and the whole is finally submitted to strong pressure. When dry the covered wire is passed through a bath of boiling linseed oil, being left in it until the covering is saturated. This makes it elastic and impermeable to moisture.

Electricity and Veterinary Surgery.—Two members of the Vienna Military Veterinary Institute have introduced an improvement in the use of the laryngeal mirror for horses. The ordinary mirror, which at its outer end has an incandescent electric light, is introduced into the nostril, and at once makes visible any symptoms of nasal mucus and other diseases which call for the prompt isolation of the animal. The operation has proved possible even in the case of obstinate horses, and a quiet animal will submit to it without resistance.

The Maritime Conference.—At the meeting of this Conference, on the 4th inst., it was decided, by fifteen to four, to have a special fog signal for vessels not under command, or laying or picking up telegraph cables. The Committee on Sound Signals recommended on the 5th inst. that a ship not under command, and unable to manœuvre as required by the regulations, will give four short blasts. A ship engaged in laying or picking up a cable will give three prolonged blasts in succession. After discussion, the recommendations of the committee were adopted.

St. Petersburg.—The Belgian Consul at St. Petersburg states that electric lighting makes rapid progress there as well as at Moscow, in "the palaces," administrative offices, theatres, public halls, business and private houses. In the course of this summer the installation of a new central electrical station was started at St. Petersburg, as also the laying of subterranean lines. Electric lighting has been adopted in a good part of the Vibourg quarter, at the Academy of Medicine, and the Finland Railway Station, &c. The Second Tramway Company proposes to replace its steam locomotives by electric motors.

Exeter.—The dislike of the Town Council to overhead wires does not appear to have diminished. At the last meeting of the Council a long discussion took place upon the recommendation of the General Purposes Committee that the Electric Light Company should be asked to place switches at various points in their circuits, so that the superintendent of the fire brigade might be able to cut off the current in cases of urgency. Several resolutions adverse to the continuance of the overhead wire system were moved, and nearly carried, and the subject was finally dropped without any decision being arrived at.

Royal Institution.—The following are the lectures on electrical subjects arranged for before Easter:—Prof. A. W. Rücker, six Christmas lectures to juveniles on Electricity; the Right

Digitized by Google

Hon. Lord Rayleigh, seven lectures on Electricity and Magnetism. The Friday evening meetings will begin on January 24th, when a discourse will be given by Professor Dewar on the Scientific Work of Joule; succeeding discourses will probably be given by Sir Frederick Abel, Prof. J. A. Fleming, Mr. Shelford Bidwell, Prof. T. E. Thorpe, Prof. G. F. Fitzgerald, the Right Hon. Lord Rayleigh, and others.

Long-Distance Transmission in Algeria.—The municipality of Mascara (Algeria) has signed a contract for the lighting of the streets of the town by electricity. The concession is for 45 years, and the town is to pay 10,500fr. per annum for 150 16 candle-power lamps. The *concessionnaire* is given free use of the waterfall at Ain-Fekan, 30 kilometres distant, and the dynamos will have to actuate for 14 hours per day the pumps at the springs of Sidi-Daho, eight kilometres distant. The installation will thus afford an interesting example of the application of electricity to long-distance transmission of power.

Barnsley.—A correspondent writes us from Barnsley, enclosing a large yellow poster, headed "Electric Lighting and its Dangers,"—"a specimen of many hundreds that have been posted in and around Barnsley by some persons evidently not in favour of electric lighting." This document is a concise summary of Mr. Edison's recent alarmist article in the *North American Review*, and, unless its contents were taken with a grain of salt, they would, no doubt, be very unpleasant reading. We have no fear, however, that Barnsley, if it means to have the electric light, will be deterred from so doing by an alarmist poster.

Telephone Lectures.—A class has been formed in connection with the Leeds staff of the National Telephone Company, for the study of telephony and electricity, conducted by Mr. A. L. E. Drummond, the local manager. The first meeting was held on Wednesday evening, November 20, 1889, when Mr. J. C. Chambers, M.I.E.E., general manager of the Yorkshire district, gave the inaugural address. This was followed by Mr. Drummond's first lecture, dealing principally with the Léclanché Cell and its connection with the telephone. The following lectures were respectively on the "Blake Transmitter" and on "Magnetism." These lectures, which are much appreciated by the staff, are to be continued each Tuesday evening throughout the winter months.

Overhead Telephone Wires as Lightning Protectors.—It would seem, according to a recently-published correspondence between Dr. Stephan and the Madgeburg Insurance Company, that a overhead telephone system forms a very effectual protection against lightning. From 1883 to 1888 there has only been one case of damage by lightning in the centre of Hamburg, where the wires are dense, while there have been numerous instances in the suburbs. A similar immunity has been experienced in Berlin, and other towns where there are large numbers of overhead telephone wires. Dr. Stephan points out in this correspondence that the German telephone systems are constructed with the greatest care and are well provided with lightning arresters.

The Kensington Electric Lighting Mains.—At the last meeting of the Kensington Vestry, the Works Committee reported having considered a drawing of cover proposed to be put down in the roadway at the entrance to Kensington Court, by the Kensington and Knightsbridge Electric Lighting Company, such cover being 3ft. 6in. square, and recommended that the sanction of the Vestry be not given for the laying of any covers in the roadway of the size of the one mentioned. Attention was called to the nuisance caused by pipes lying in the roadway. The Surveyor said it took him quite one hour and a-half a day to write and look after these Companies. After several complaints on the part of various members of the Vestry, it was decided that a strong letter should be written to the several Companies.

Exports of Electrical Apparatus, &c.—The Board of Trade returns for November are again very satisfactory as regards the exports of telegraphic wires and apparatus connected therewith. Not only do the figures for the month of November compare very favourably, but the aggregate value of our exports this year is very much in excess of the corresponding amount on November 30, 1888 and 1887. We append a comparative statement for the past three years:—

	1887.	1888.	1889.
Jan. 1st to June 30th	£188,812	£244,213	£576,456
July 1st to Sept. 30th	468,252	152,926	117,460
October	31,475	17,938	205,603
November	14,089	18,566	113,306
Eleven months	£702,628	£432,743	£1,012,825

Proposed Cable between Cayenne and the Antilles.—A very interesting question was settled in the last Session of the General Council of Cayenne. This Assembly has voted an annual subsidy of 80,000fr. in favour of the submarine cable company which has undertaken to lay within a year of the signature of the convention a submarine cable between this colony and the French Antilles. The same company has made contracts with Martinique and Guadaloupe, which substitute it for the English company now bound to maintain telegraphic communication between France and the Antilles, and which company's privilege expires at the end of this year for Guadaloupe, and in 1892 only for Martinique. We may therefore anticipate that French Guyana will be connected with the Antilles, and consequently with the general system, in a few months.

The Telephone in Germany.—Telephone exchanges are now established in 176 towns in Germany, the total number of subscribers being 33,460. The following are some interesting statistics with regard to the four principal towns:—

	Subscribers.	Messages per day.
Berlin	9,534	187,371
Hamburg	3,574	80,181
Dresden	1,566	24,946
Leipzig	1,235	25,496

Trunk lines with 10,751 kilometres of wire connect 169 towns. On the Hamburg-Leipzig trunk wire there are on an average 362 calls per day, on the Bremen-Bremerhaven wire the average is only 292, while between Cologne and Bonn it is 235, between Berlin and Hamburg 213, between Kiel and Flensburg 13, and between Berlin and Dessau only 5.

The Drummond Railway Signalling Device.—A very simple and effective apparatus has been devised by Mr. Dugald Drummond, of the Caledonian Railway, and has been tried by him experimentally with good results. The apparatus consists essentially of a guide bar fixed on the road at a slight angle to the rail, and a trigger carried on the locomotive. When the guide bar is raised the trigger slides along its edge, and is gradually pushed sideways until it trips a locking catch and releases a rod which is subject to the action of a spring. This rod may be connected to a valve, when the train is fitted with air or vacuum brakes, or it may carry electrical contacts to set a gong in action. In the former case the brake is applied automatically on passing a signal set to danger, and in the latter the driver is warned that he has not a clear road before him. The cost of fitting the apparatus to a locomotive is said to be very moderate.

The Electric Light at the Royal Castle of Pelesh.—The Castle of Pelesh, which is the country seat of the King of Roumania, and is some 80 miles north of Bucharest, contains a very complete electric light installation. Power is obtained from a waterfall close by. The plant comprises three 150 ampere 110 volt Edison machines; a 10 ampere 800 volt Brush machine; a self-excited Gramme alternator, giving 100 volts and 28 amperes; and a shunt-wound Gramme machine, giving 20 amperes and 110 volts. The dynamos are driven by Girard turbines, and the mains are lead covered. The lights comprise 685 incandescents of various candle-power, and 100 Jablochkoff candles. Twenty-five 100 candle-power incandescents light up the approach to the castle for a distance of 1,000 yards. The Royal Palace at Bucharest has also been lighted by the electric light since 1883, 1,580 10 candle-power incandescents being installed.

Government Telegraph Code for India.—A publication, called "Telegraph Word Code," has, says the *Indian Engineer*, been compiled for the Government of India, under the

Digitized by Google

orders of the Director-General of Railways, by Mr. F. B. Hebbert, Assistant Director-General of Railways, for use on Indian State Railways, which it is desired to bring in use as fast as it is found convenient, with a view to reducing the expenses incurred on Public Service messages sent over the wires of the Telegraph Department. The first section of the pamphlet is intended specially for use in transmitting telegrams concerning returns called for from the railway administrations throughout India, and will be brought into use at once. The abbreviations accepted by the Railway Conference of 1888 for use as code initials for the principal railways and railway stations in India have been embodied in the publication, and similarly the names of returns, &c., have been so abbreviated that the method will greatly reduce the work thrown on the Telegraph Department.

Dockyard Central Lighting Stations.—In the forthcoming Navy Estimates, says the Portsmouth correspondent of the *Times*, a sum of money will be asked for to provide an important and much-needed improvement in Portsmouth Dockyard. The work below decks in ships after being launched is comparatively slow in consequence of the obscurity in which it is carried on. When the work in progress is so far advanced towards completion that the steam power of the ships can be brought into requisition, or where ships are docked for repairs, it is customary to make use of electric lamps. But it is obvious that in periods of emergency, when it would be of paramount importance to get ships ready with the utmost despatch, the work of preparation would have to be continued throughout the night, and with all speed. It is now proposed to erect central electric stations in connection with the various docks and basins, so that ships repairing, refitting, or completing for sea may be brought close at hand and their own wires connected with the stations.

The Buenos Ayres-Monte Video Telephone Line.—The trunk line connecting Buenos Ayres and Monte Video was opened with considerable ceremony on October 26th. This line, which is 186 miles long, is worked on the Van Rysselberghe system. The work of construction was entrusted by a private company to M. C. Laborde, and the Felten and Guilleaume cables and bronze wires were supplied by Messrs. W. F. Dennis and Co., of Billiter-street. The line is carried on posts along either side of the River Plate from Buenos Ayres and Monte Video respectively, to the points where the river is crossed. The connection here is established by means of submarine cables, which cross the river at a breadth of 28 miles. In the vicinity of Monte Video the bronze wire spans a distance of 460 yards across the river Santa Lucia, by means of poles 108ft. in height. The charges for the use of the telephone are worthy of notice. During the busiest part of the day they are as follows:—For five minutes' use $5, for five to 10 minutes' use $12 50c., for 10 to 15 minutes' use $25. The line has so far given satisfaction both as regards articulation and loudness.

Curious Treatment of an Electric Meter.—An action was recently brought by Messrs. Chamberlain and Hookham against Messrs. Scott and Co., of Jermyn-street, to recover £16. 5s., the price of an electric meter. The meter was made by the plaintiffs according to a patent by Mr. Hookham, and supplied to and accepted by the defendants. No complaint was made about its working until application was made for payment. Defendants then wrote that the meter would not work. Plaintiffs sent their engineer to see the meter, and he found that a gardener was in charge of it, and he used it as he would a hot-water pipe. The engineer carefully examined the meter, and had it set right, but the meter would not work. He then discovered that it had been switched out of circuit, but the moment the current was turned on the meter worked correctly. Further complaints, however, were made by the defendants, and plaintiffs sent word to them to let the meter alone, and not let the gardener manure it, and it would then go all right. The defence was that the meter would not act properly under any circumstances. Verdict for the plaintiffs.

The National Telephone Company.—On Friday last the eighth annual assembly of the National Telephone Company was held in the St. Andrew's Halls, Glasgow. Over 300 attended, and amongst those present were Sir William Thomson, Messrs. W. Alex. Smith, resident director, D. Johnston Smith, district secretary; W. R. W. Smith, D. Sinclair, district engineer. During an interval Sir William Thomson expressed regret at the unavoidable absence of Colonel Jackson, whose health had broken down through the great stress put upon it in managing such a gigantic and progressive concern as the National Telephone Company. The past year, he said, had been an eventful one in the Company's existence, as during that time the three leading companies in Britain had amalgamated, and there were still pending negotiations for a further amalgamation. The National Telephone Company had 32,000 miles of wire in connection, while the "calls" were 73,000,000 per year, which was equal to 380 "calls" per minute, or more than six per second. In Scotland they had 54 towns connected with their exchange, and with the addition of Dundee, which would be made in two months hence, they would be able to speak with 55 different places. They had also hopes of overcoming the difficulty in connecting with Ireland. The present obstacle was the expense of laying 30 miles of cable, but he believed that by another year the expenditure necessary would not be found to be a barrier.

The Eickemeyer Storage Battery.—This battery consists of a flat cast-lead plate foundation provided with a number of polygonal-shaped holes. These openings are lined with active material which is well packed around plugs, which, when removed, leave central circular openings. Each plate has a projecting terminal and all are counterparts cast from the same pattern, so that when reversed in position and piled one on another with the terminals located alternately on opposite sides, the holes register with corresponding holes in all the plates throughout the pile. Between each two plates there is placed an insulating plate, which is also provided with holes corresponding to those in the lead plates. With the battery thus constructed each vertical line of holes constitutes a chamber for containing the electrolyte, and this is supplied by means of a funnel which tightly fits the feed aperture at the top. As the liquid falls to the bottom of the battery it is distributed by way of lower channels and openings in the base-plate to the several cells, in which it rises with uniformity until all are properly filled. An extensive area of the porous material is thus exposed to the electrolyte, and the metallic lead of each grid is completely protected against the liquid except through the active material. Mr. Eickemeyer has designed various forms of these cells, all embodying the same principles, and resulting, it is claimed, in a cell of considerably reduced weight in proportion to its storage capacity.

The Specific Resistance of Amalgams of Sodium and Potassium.—In these investigations, says Prof. Grimaldi in *Il Nuovo Cimento*, I determined the electrical resistance of several amalgams of sodium and potassium of different degrees of concentration, with a view of ascertaining their chemical constitution. The determinations were effected either by the Wheatstone Bridge or by Kirchoff's method. The amalgams were contained in U-shaped glass tubes, and minute precautions were taken in drying and in filling the tubes. I noticed that amalgams, rich in sodium and which solidified, had a specific resistance less than that of pure mercury. But if the resistance of an amalgam is determined at 0°C. before and after heating, its latter resistance is found to be higher. This permanent increase in resistance is proportionate to the intensity of the heat applied and to the duration of its application. This would seem to indicate that these amalgams are composed of two distinct parts, which are separated by heat. Liquid amalgams containing but a small amount of sodium, and prepared by the direct union of the two metals, have a higher specific resistance than pure mercury. The resistance of two amalgams, one of which contained twice as much sodium as the other, was found to be the same. On the other hand, the resistance of liquid amalgams, obtained by dissolving crystalised Na_2Hg_{12} in mercury, became less as the quantity of sodium was diminished. This difference leads one to suppose that there exists a definite liquid amalgam containing a small amount of sodium, which is confirmed by the fact that two amalgams, equally rich in sodium but prepared by two different processes, showed different resistances.

Digitized by Google

REVIEWS.

The Alternate Current Transformer in Theory and Practice. By J. A. Fleming, M.A., D.Sc., Professor of Electrical Engineering in University College, London, &c., 8vo., 487 + xii. pp. (London: "The Electrician" Printing and Publishing Company, Limited, 1889.)

(Concluded from page 111.)

Continuing this section of Chapter II., Dr. Fleming then treats of the magnetic properties of iron. It seems a pity, in view of modern modes of thought, that the subject of magnetic permeability should have been approached by Dr. Fleming through the antique road of surface distribution of free magnetism and the notion of susceptibility. Let the magnetising force at any point be called **H**; the meaning of this symbol is best comprehended by the ideal process of placing a unit magnetic pole at that point and measuring the number of dynes of force with which it is urged forward by the magnetic action. To say that the intensity of the magnetic force is **H** means that a unit pole placed there would be acted on with a force of **H** dynes. In the medium of which the properties are taken as a standard, namely air, the convention adopted is this: that we may draw as many lines through unit area as there are dynes on unit pole. But if the medium is one of higher magnetic power, the number of magnetic lines which result from the same magnetising force will be greater, and is called **B**. The coefficient which represents the ratio of **B** to **H** is called the permeability of the medium, and the usual symbol for it is the letter μ; so that $\mathbf{B} = \mu \times \mathbf{H}$. So that if the magnetising force were such as to evoke **H** lines to the square centimetre in air, there will be μ times as many in the iron. This idea is of the simplest kind. When the old ideas were prevalent (as they still are in the academic text-books and on the Continent) that the "free magnetism" is something residing on the surface of the magnet, plastered on, as it were, over the ends and adjacent parts, it was convenient to employ a symbol —usually the letter κ—to indicate how many units of surface magnetism there would appear on the end surface per square centimetre when the iron was subjected a uniform longitudinal magnetising force **H**. Calling the number of surface units per square centimetre **I**, one then had the relation $\mathbf{I} = \kappa \times \mathbf{H}$. After this, since each surface unit of magnetism on the end of the magnet corresponds to the passage through the surface of 4π magnetic lines, it becomes clear that the number of lines which the presence of the iron adds to those that there would have been in air is $4\pi\mathbf{I}$ per square centimetre, or that to the original **H** the iron adds $4\pi\kappa\mathbf{H}$ lines. Hence the whole number of lines passing through the square centimetre, where the magnetising force is **H**, will be $(1 + 4\pi\kappa) \times \mathbf{H}$. Having got so far, one is then told that this complex factor is called the permeability, and symbolised by the letter μ. But why all this roundabout way of leading up to the simple idea of permeability? The notion of susceptibility which intervenes is never wanted in modern practice, and is, in fact, a more or less misleading notion, as it makes beginners think more of the accidental surface phenomena and less of the real permeation of the magnetism through the interior. Having made this criticism, it is more pleasant to add, that in the data that follow about permeability curves and their difference in different materials, the matter is abundant and the manner of presentation quite satisfactory. So, also, is the second section of this chapter, relating to the induction of currents, or, rather, of electromotive forces, down to near its end. The effects of self-induction in a circuit, and the modes of exhibiting its action, are very carefully and clearly explained, with diagrams illustrative of experiments on the point. We come, however, at page 51, upon a matter where Dr. Fleming departs, as it seems to us unwisely, from a usage which, though of modern date, is certainly accepted by many able teachers. Dr. Fleming uses the word "inductance" as if it were the synonym of "coefficient of self-induction." We are not going to accuse Dr. Fleming of any confusion of ideas, either in his own mind or in his writing; he knows perfectly well, and has stated clearly in other places in his book, that the effects of electro-magnetic momentum in retarding the phase of periodic currents, and in diminishing their amplitudes, are dependent upon the coefficient of self-induction and upon the periodicity of the current; nay, more, that the two factors periodicity and coefficient of self-induction come in with absolutely equal weight into the expression for the retardation of phase and into the expression for the diminution of amplitude. Both these effects depend upon the ratio between the resistance of the circuit and the quantity which is ordinarily expressed by the symbols $2\pi n\mathrm{L}$, where n is the periodicity or number of alternations per second, and L the coefficient of self-induction. Now, the term "inductance," as mostly used, is applied to the whole of this quantity, the impedance, or virtual resistance in the circuit being made up partly of true resistance and partly of inductance, being, in fact, the square-root of the sum of their squares. The angle of lag can then be defined as that angle whose tangent is the ratio of inductance to resistance. Dr. Fleming's new use of the term inductance robs us, however, of this convenient way of stating these matters. It is to be hoped that he will reconsider the point before issuing a second edition. As a rule, Dr. Fleming is very careful in observing the distinction—so greatly neglected by Continental writers—between work and rate of doing work. There is, however, an ambiguity on page 53, where it is not clear whether $d\mathrm{E}$ is used for an element of work or for an element of rate of work. The use of the symbol E for work is in itself unfortunate.

It is gratifying to note that Dr. Fleming has the courage to adopt and use the expression "magnetic resistance" for the ratio of the line integral of the magnetising force to the total magnetic induction in a magnetic circuit; the more so because the objection that has been taken to the use of this convenient term is based on a fallacy.

Those whose knowledge of the theory of electricity and magnetism is of the academic order will receive rather a rude shock when they discover from page 55 that the three modes of defining the coefficient of self-induction, which academically are identical, lead to three different values in the case of real magnetic materials. A summary of the researches of Dr. Sumpner on this matter is given, together with a discussion of the relations between the coefficients as variously defined, and the curves of magnetisation.

An excellent summary of the researches of Ewing on hysteresis closes Chapter II. It is a pity that the subsequent data on p. 287 were not included with those in this earlier section.

The third chapter of Dr. Fleming's work is devoted to the theory of simple periodic currents, and opens with an exquisitely clear and complete account of harmonic motion in general, and of Fourier's theorem in particular. This section might with advantage be studied by all teachers of mathematics as an example of the way to let the light of common sense illuminate an abstract topic, which is too often made repulsive to the beginner by the bald and uninteresting mode in which it is presented. It is true that Dr. Fleming does not scruple to make use of either the notation or the methods of both differential and integral calculus when the occasion requires. And he is quite right too. The engineer, whether mechanical or electrical, who has not grasped the fundamental ideas which are conveyed by the two symbols the little d and the long $\int$ is distinctly the mental inferior of him who, whether he actually uses the symbols or not, knows the significance of the two operations. They are as essential to the intelligent understanding of the facts of Nature as are the operations denoted by the symbols $\div$ and $+$, which operations many persons perform continually without actually using the symbols. Unfortunately, the British schoolboy is handicapped, as compared with his continental compeers, by having to spend weary months on "long" division and "long" multiplication, "reduction," and other brain-wasting rules, from which his rivals are preserved by the happy accident of possessing a rational system of weights and measures in which there are no tables to learn and no reductions save by multiples of ten. So the British schoolboy is altogether denied at school any inkling of even the elements of the calculus, though logically he ought to begin this before he attacks trigonometry. Nature, however, asserts herself in spite of national prejudice and academic conservatism. It is impossible to take many

Digitized by Google

steps into the study of natural facts without realising the necessity in some shape of dealing by some sort of a calculus with the variations of things, simply because in Nature things do vary, and increase, and decrease. True, the mathematical prudes try to keep back from the mind as long as possible the use of the simple natural language for expressing facts about variation and increments and the integral sum of the increments. They foist upon him, so as to prevent him learning or using the sacred symbols d and $\int$, dry and dreary pages of long-winded algebraical "proofs," in order to establish some point for which two lines of crystallised common sense in the shape of a most elementary integration would have sufficed. And the result of their prudery is that the British schoolboy grows up with a sort of shuddering dread of the little d and the long $\int$ as of something which only a university man can tackle or understand. "It is generally easier," says Dr. Fleming, "to master the elements of the calculus than to construct or follow proofs which aim at avoiding its use." We heartily commend this golden sentence to the thousand teachers of academic mathematics who are still trying to drive their bewildered and belated pupils along the narrow path of Todhunterian method, or through the tortuous defiles of the so called "geometrical" conics, that hybrid study which is neither purely geometrical nor analytical, but which uses complex algebraic proofs to demonstrate matters that are far more simply proved by the most elementary calculus. Dr. Fleming is here no unworthy follower of Clifford. Those who prefer that things should be taught in old-fashioned ways, and do not value modern methods of teaching, may spare themselves the trouble of reading Dr. Fleming's book. Using, then, both the notation and the methods of the calculus, but elucidating every point both by geometrical illustrations and by clear explanatory remarks, Chapter III. proceeds to establish the laws of current growth in inductive circuits. These include both the case where the electromotive force of finite amount is suddenly applied—as by the switching-in of a battery of cells—and the case of a periodic electromotive force, such as that of a simple alternate-current generator. The differential equations are built up bit by bit and duly integrated, and so page 109 brings us to the well-known rule for sine-currents, with the modification of Ohm's law, wherein impedance takes the place of resistance. Here a sentence or two might have been amplified with advantage; but the geometrical illustrations which follow atone for the previous brevity. The illustrations from pages 120 to 125 of the give-and-take of power in the four stages of a complete period of alternation of the current are excellent. So is the geometrical method of treating the mutual induction between two circuits which follows. The use of the clock-diagram for studying harmonic motions, due originally to Thomson and Tait, and applied by Blakesley and by Kapp to the study of alternate-current problems, is here greatly developed: it virtually becomes in Dr. Fleming's hands a graphic theory of the alternate-current transformer. It seems a pity that whilst the ordinary spark coil is fairly fully treated on pages 181-191, the theory of the use of the condenser in conjunction with it is given, without any cross-reference, on page 383.

One omission we notice, namely, the absence of any direct account of the effect of self-induction in smoothing out the ripples in the waves of electromotive force. This omission is the more curious, as the careful statement of Fourier's law in the early part of the work had paved the way for treatment of this topic.

Chapter IV., which occupies the middle third of the book, opens with a narration of a number of purely experimental researches. Here we have by far the best and most complete abstract accessible to students of the researches of that truly great man, Prof. Henry, who has hitherto received far too faint a recognition for his work on current induction. His investigation of the higher order of induced currents is better known than some of his other researches. He discovered and most distinctly describes the use of the induction coil, so arranged as to give out from the thick-wire secondary a larger current (but at lower pressure) than the current imparted to the fine-wire primary, or, as he expressed it in the not too precise language of that time, he proved that an intensity current can induce a quantity current. From this Dr. Fleming goes on to the theory of the spark-coil, where, instead of an alternating electromotive force, an abruptly intermittent one is applied to the primary wire by means of a self-acting rapid break. This leads to the researches of Breguet and Masson, and to the more modern investigations of Blaserna, Helmholtz, Hughes, Grant, and Willoughby Smith, together with brief references to the mathematical writings of Lord Rayleigh and Mr. Oliver Heaviside; and these lead again to the later experiments of Hughes, and the fact now amply established that periodic currents, unlike steady ones, do not flow equally through the whole cross-section of the copper conductor, but seek the outside layers, so distributing themselves through the cross-section as to make the self-induction a minimum. The action of "choking-coils," and the influence upon them of tbe variations of permeability in their iron cores, is next considered. From this point Dr. Fleming turns back once more to the subject of transformers; this time to deal with them as containing iron cores, the clock-diagrams coming in again, but modified so as to take in the additional facts. There is, doubtless, an advantage in this order of treatment; but it is a little unfortunate that the three passages of the book, namely, pages 146-154, 269-282, and 302-304, which give the theory of transformers, firstly, with air circuits; secondly, with iron circuits; thirdly, with iron and air circuits, are not all consecutive. It is still more unfortunate that the notation used in them is not quite consistent; for example, N sometimes stands for the coefficient of self-induction of the secondary circuit, and sometimes for the number of windings in a coil. Brief references are given to the several tests made on actual transformers by Ayrton, Cardew, and Ferraris.

Chapter V., which forms the last third of the book, is of a more speculative order, being devoted to the dynamical theory of current induction: that is to say, it deals with those modorn views of induction phenomena which have resulted from Maxwell's study of Faraday's researches and opinions. These modern views have lately been independently treated of by Prof. Oliver Lodge in his own inimitable manner in the volume lately reviewed in these columns.* It is interesting to have in Dr. Fleming's work another account of the same field of investigation. Maxwell's theory of electric "displacement" as the equivalent, in a dielectric, of the ordinary current in a conductor, is the key-note to his later theory of molecular vortices. We have here explained to us by Dr. Fleming the mechanical model which Maxwell imagined for the purpose of explaining the phenomena of electro-magnetic induction, all space being considered as made up of elastic wheels geared together with intermediate "idle" wheels, a mechanism which Prof. Lodge has lately somewhat developed. Maxwell's electro-magnetic theory of light, which resulted from his study of the necessary equations for expressing the properties of the electro-magnetic field, naturally follows in due course, and is succeeded by a discussion of electric oscillations, of the recent researches of Prof. Lodge and of those of Prof. Hertz, which have lately claimed so much attention from the scientific world. Of these a very full account is given; being, indeed, an almost complete transcript of the excellent abstract by Mr. de Tunzelmann, which originally appeared in *The Electrician*.† After this Dr. Fleming brings his first volume to an end, with a few closing remarks on the modern views. In respect of these there is no fundamental difference between him and Dr. Lodge; indeed, the facts give no room for much difference. No electrician who has taken the trouble to study the facts, and who has the capacity to follow their inescapable consequences, can fail to learn that the energy of a so-called electric current is not transferred longitudinally along the substance of the conducting wire (as used to be supposed), but is transferred into it sideways, travelling, not along the wire, but across the insulating medium which surrounds it. The truth that insulators convey the energy and do not dissipate it, whilst conductors (so-called) dissipate the energy and do not convey it, is a hard saying te the half-educated electrician. Yet it is the legitimate outcome, as Dr. Fleming says, of that half-

* *The Electrician*, August 23 and 30 1889.

† Vol. XXI., pp. 587, 625. 663, 696, 725 757 788

Digitized by Google

century of scientific thought which dates from the period of Faraday's conception of an electro-magnetic medium.

When Dr. Fleming gives us his second volume, he may fill it with an equally excellent account of the practical work that is being done with transformers for the purpose of distributing electric energy for lighting, welding, and motive power; but we venture to doubt whether his second volume, however excellent, can have the value of his first in educating the electrical engineer in modern developments and progressive views. Some of the points which have called for criticism arise from the fact that portions of the book were written as serial articles for the press. That the completed work should show so little trace of this is greatly to its author's credit. His historical notes of reference are numerous and excellent, and absolutely devoid of partiality. It is a book which the electrical engineer of the present and of the future alike will read—he of the present, if he can; he of the future, because he must.

SILVANUS P. THOMPSON.

A COMPARISON BETWEEN THE CONTINENTAL, AMERICAN, AND ENGLISH DYNAMO-ELECTRIC MACHINERY.

BY ALBION T. SNELL.

(Concluded from page 59.)

The Continental dynamos have several details differing widely from English practice. Amongst these the solid bearings with metal discs fixed to the journal for distributing the oil may be mentioned. This style of automatic lubrication is very general in France, and is used in a modified form by the Edison Company in America. (*The Electrician*, September 6th, p. 446). The Oerlikon machines have ordinary split bearings of round design. A peculiar feature of many machines is the use of a *gravity* brush, somewhat like that adopted in the Parsons' steam turbine dynamo. For many purposes these brushes seem to work very satisfactorily; but the armature must evidently be fairly free from vibration. Another type of brush also very common on the Continent is shown in Fig. 15, which illustrates the Alsacienne brush-holders. It will be seen that the brush and its holder are carried by a long curved spring. The pressure on the commutator can be adjusted either from the pin carrying the spring, or by shifting the brush itself in the holder. This design seems to work well. It is extremely simple, and should find favour amongst English designers. I have not seen the principle applied before. The brushes are sometimes made from brass, and sometimes copper: both metals seem to be equally favoured. Copper gauze is used by a number of firms, and generally wears well. Gauze brushes are just now the *thing* amongst us. I imagine, though, they will have their day. Experience seems to show that no one type of brush will suit every class of machine. The character of the work has no little influence on the results obtained, and the indiscriminate use of any particular style of brush cannot meet with complete success. With motors subject to very large variation of load and intermittent work, the carbon brush appears to be the most successful, if we may believe the high praise given them in America as well as on the Continent. For motors running with a fairly constant load, probably thin copper plates at a tangent to the commutator are the safest. Copper gauze is excellent as long as it keeps cool; but if sparking once commences the fragile material is soon destroyed.

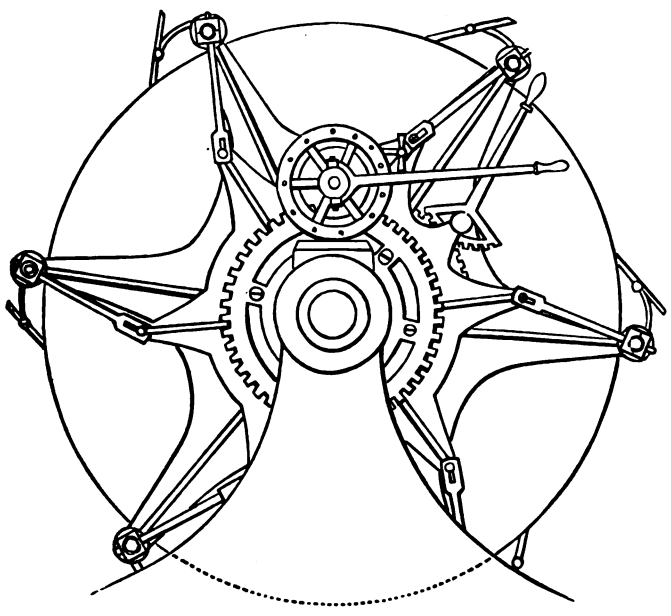


FIG. 15.—Brush-holder of the Alsacienne Dynamo.

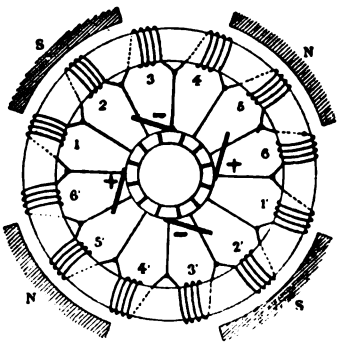


FIG. 16.—Four parallels, four brushes.

The different commutators in the Exhibition were a study in themselves. There were pure copper forgings, cast segments in copper, and bronze alloys, and segments cut from cast rings. The Alsacienne Company, on their two-pole over-type dynamo of 60,000 watts, have a commutator built up of a fine, hardened iron. This latter has the segments fixed by screws to insulated pieces of brass, which are connected with the armature winding, the insulation between the segments being air. The segments overhang from the point of output, and so are insulated by an air space from the shaft. The machine seems to run well, and is practically sparkless.

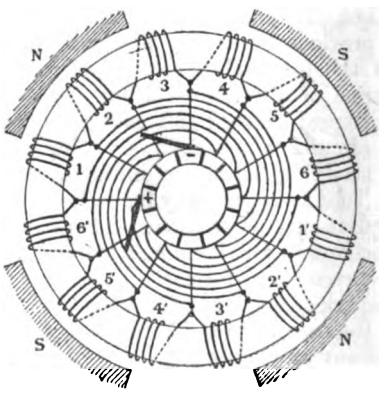


FIG. 17.—Four parallels, two brushes.

The insulating materials used on the commutators were various—mica, asbestos, and vulcanised fibre. In England asbestos has almost gone out for insulating commutators, mica being almost invariably employed instead, while vulcanised fibre is used for the rings. With a few notable exceptions the Continental commutators appear to be inferior in workmanship and design to those made in England.

The windings of the armatures and fields of both Continental and American machines are, as a rule, not so carefully carried out as those of the best firms amongst us; but in most cases the work is sound, if rough. Some firms, however, turn out their winding with a finish equal to the best in England. Amongst these the Oerlikon, Thury, and Alioth Companies are specially notable. The Continental Edison do not seem to

Digitized by Google

pay such attention to this detail as the parent company does. The American Edison high-tension drum armatures are masterpieces of this difficult branch of the electrical trade. The Thomson-Houston arc dynamos must also be very carefully wound to stand such high tensions. The incandescent, alternating, and welding dynamos by the same company are now well finished in this respect. The early machines shown in Europe were very rough.

In England there seems to be mainly two methods of winding, both having closed coils. The first is the well-known Gramme winding, which is applicable to ring, cylinder, and disc armatures, with two or more poles. The second is adapted for drum types, and is usually a modification of the Alteneck method, and practically is only used with two-pole machines. In America also,

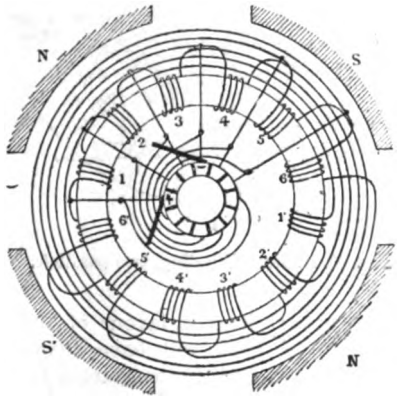


FIG. 18.—Two parallels.

excepting the Brush and Thomson-Houston Companies, the practice is similar. The Edison drum winding is really only a modification of the original idea of Siemens. Continental engineers seem to have used these simple windings to a large extent also; but the extensive use of multipolar machines has led to the invention of several very interesting methods of winding not very well known over here.

I am indebted to an article by M. W. C. Rechniewski in No. 24 of *La Lumière Electrique* for 1887 for some of the following diagrams. Whether the complications involved in some of them are worth the results gained only experience can show in

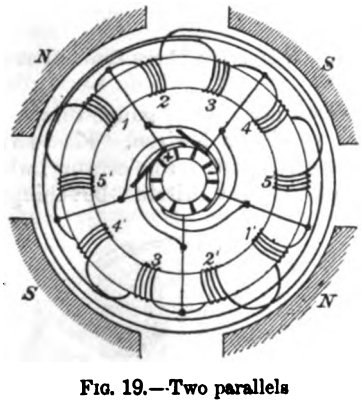


FIG. 19.—Two parallels

a conclusive way; but they are certainly ingenious, and merit some study. To properly appreciate them, it will be necessary to start from the simple designs in general use for multipolar machines. Fig. 16 is a diagram of a four-pole cylinder armature, with four brushes, the opposite brushes being of the same sign. In practice this winding is used for large currents and relatively low potentials. The opposite brushes are coupled in parallel. The Gülcher dynamos are wound in this style. Fig. 17 is the diagram of a similar winding, with the coils also coupled in four parallels. But opposite coils of the same potential are coupled together, and only two brushes are really necessary. Four brushes are, however, a convenience in practice, for two can be kept in reserve. This coupling is due to Mr. Mordey, and is used in the Victoria Dynamos. Fig. 18 shows one method of coupling the coils in two parallels. This arrangement gives a tension twice as great as that shown in Fig. 17 for a given number of turns of wire—the current, of course, being correspondingly reduced. It will be noticed that opposite segments of the commutator are joined together, and that opposite coils are also coupled in series. The connections are somewhat cumbersome, but the winding is symmetrical. Two brushes only, at 90° to each, are generally used. Figs. 19 and 20 are simplifications of this design. Alternate coils are connected to alternate segments of the commutator, and opposite segments of the commutator are joined. It will be noticed on carefully inspecting these two diagrams that, in order to make the winding symmetrical, it is necessary that the number of coils on the armature be not a multiple of the number of pairs of field poles. Fig. 19 illustrates

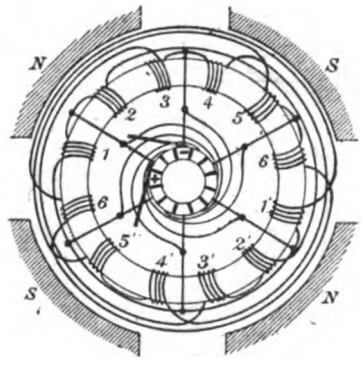


FIG. 20.—Two parallels.

the symmetrical winding; Fig. 20 the unsymmetrical. In both methods there will be an unequal resistance in the two parallels, since one pair of coils will always be short-circuited by one of the brushes. This difference is a matter of no importance, if the the coils be as numerous as usually obtains in practice.

Fig. 21 shows a modification of the multipolar ring winding. Each coil is connected to n segments at intervals of $\frac{360}{n}$ degrees, where n is the number of pairs of poles in the field. This winding enables the number of commutator bars to be

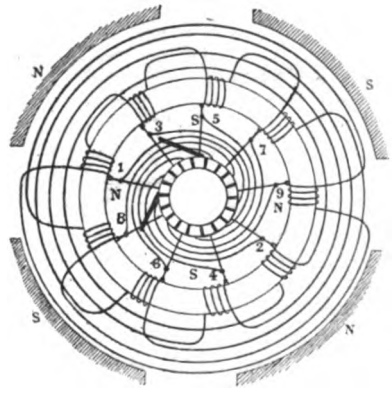


FIG. 21

increased without a corresponding increase in the number of coils. I very much doubt whether the point at issue is worth the trouble and complication of the troublesome connections. What these latter must be in practice can be imagined by inspecting Fig. 21.

This winding, adapted to a disc, is said to give extraordinary results in the Desrozier machine. A partly-finished diagram of the winding is given in Fig. 22. Note the connections, and recollect this armature consists of two complete discs with separate windings.

The Alioth winding presents several features in common with the two preceding designs; it, however, is adapted to a drum core. The diagrams for parallel and series connections are given in Figs. 23 and 24. They are copied from *The Engineer*

Digitized by Google

In an armature of 10 coils wound in four parallels the current divides as follows: starting from the negative brush it passes through the coils in four groups of two in series, two coils being short-circuited by one of the brushes. The poles are formed at the spaces covered by these two coils. Assuming the positive brush in connection with coils 3, 2, 8, and 7, the negative brush will be in connection with coils 1, 6, 4, and 9, and 5 and 10 will be short-circuited on themselves by one brush. In two parallels with the same number of coils the order of the coils is as follows: 1, 6, 7, 2, and 4, 9, 8, 3.

10 and 5 are again short-circuited by the negative brush, and they are in series with each other. The brushes are in

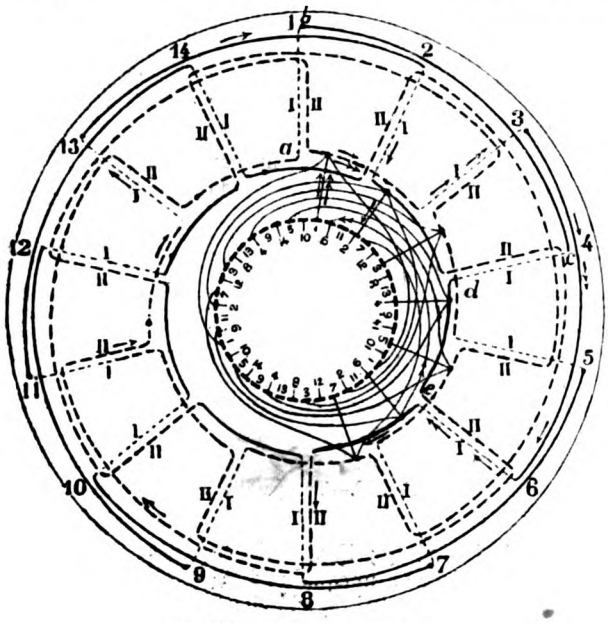


Fig. 22.—Desrozier's Winding.

each case at 90° to each other, because coils in relatively the same positions, *i.e.*, at distances of 180° to each other, are coupled.

The similarity to the ring winding in Figs. 20 and 21 is apparent.

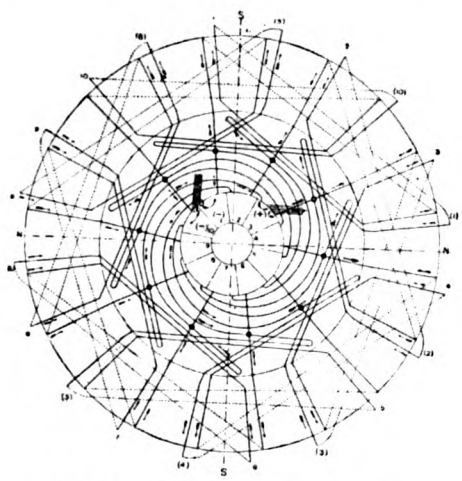


Fig. 23 —Alioth Winding, four parallels.

Fig. 25 shows an end view of a four-pole Thury drum armature winding. This design merits a close study. It will be noted that coils of largely-differing potentials are not so much in contact with each other as in the ordinary drum winding. And since the coils can be wound on shapes before being put on the core, the insulation can be made very secure. The Thury armatures shown at the Exhibition were most workmanlike, and formed a striking contrast to some of the French work. Fig. 26 is a diagram of the new Edison disc winding, patented in 1887. The arrangement is really a modification of the diagram Fig. 22. The connections are simple, and so far are a considerable improvement on the Desrozier design; the chief objection appears to be a possible difficulty in the mechanical structure.

Attention has been drawn in these articles to some of the chief features of Continental and American practice. The

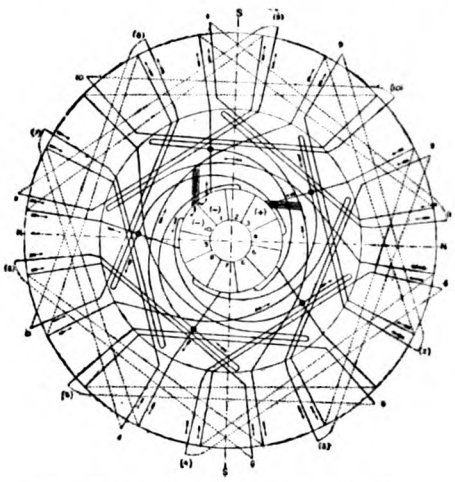


Fig. 24.—Alioth Winding, two parallels.

comparison has not always been in favour of British engineering. The Exposition of 1889 will have advanced electrical engineering amongst us in no little measure if the lessons there learnt are duly appreciated. Englishmen, and Scotchmen, too,

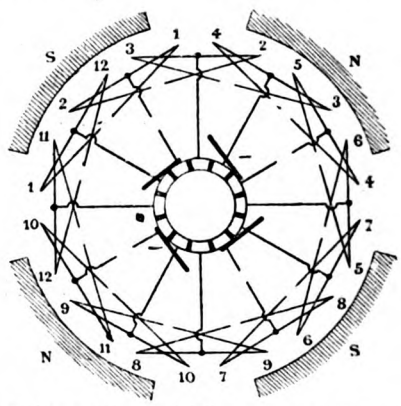


Fig. 25.—End View of four-pole Thury Drum Armature Winding.

but in a lesser degree, are apt to gauge things exclusively by the limits of their particular horizon. This sort of thing did well enough in the early part of this century, when engineering was almost confined to Great Britain: but things have changed

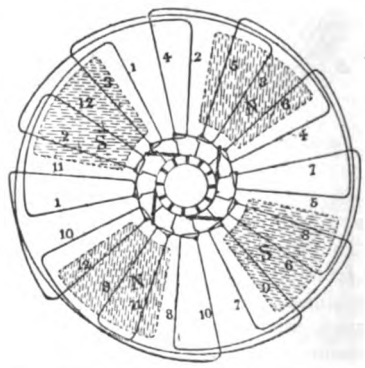


Fig. 26.—New Edison Disc Winding.

since then. The spread of technical education, the large number of industrial exhibitions, as well as the ordinary march of events, have contributed to the dissemination of knowledge, and the Continental firms are now formidable opponents in most of the branches of civil, mechanical, and electrical engineering.

Digitized by Google

THE GOOLDEN-EVERSHED OHMMETER.

We recently had an opportunity of inspecting a new apparatus that is being introduced by Messrs. W. T. Goolden and Co., for the measurement of "insulation resistances," and we must congratulate Mr. Evershed, and this firm, on being able to bring out an inexpensive instrument that is portable and apparently well suited to its purpose. The idea of an ohmmeter, if we remember rightly, is due to Profs. Ayrton and Perry; but it has been left to Mr. Evershed to carry out its construction in a manner having the necessary practical and commercial qualities. The value of insulation tests made with a few cells has never been considered great—dynamo makers, in particular, being fully aware of the lowering effect which even the application of very ordinary pressures has upon the properties of insulators. The difficulty, however, of making tests outside the factory with high E.M.F.s had stood in the way of reliable main and house-wire tests. But now that to a portable ohm or megohm-meter we have the addition of a portable 100 or 120-volt generator, we may look for better things.

In Fig. 1 is shown the complete apparatus, consisting of a direct-reading ohmmeter, graduated with a range from 10,000 ohms to five megohms, with an open scale and distinct figures, and a portable magneto-generator of special construction, enabling 100 to 120 volts to be obtained by turning the handle at the moderate speed of about 120 revolutions per minute. All that is necessary to measure the insulation resistance of any circuit is to couple the wires to be measured to the terminals, turn the handle, and the needle at once points to the number of thousand ohms or megohms representing the insulation resistance.

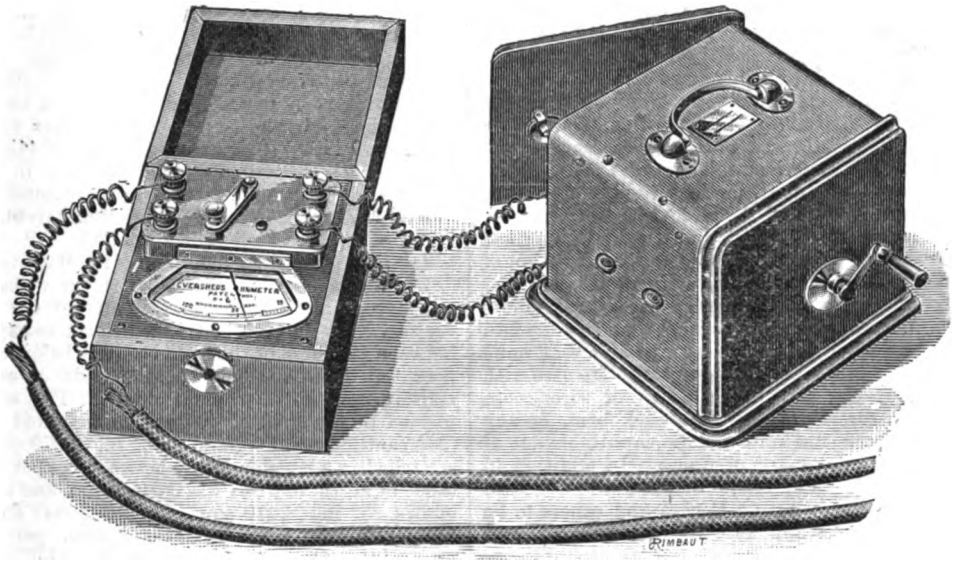


FIG. 1.—Ohmmeter and Mechanical Generator.

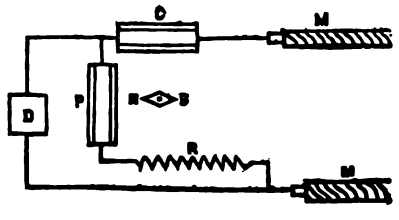


FIG. 2.—Connections of Ammeter and Generator.

In Fig. 2 the connections of the ohmmeter and generator are shown diagrammatically. The generator D and current coil C are connected in series with the mains M M, the insulation resistance of which is to be measured. The pressure coil P, with a large resistance, R, is arranged as a shunt on the generator. The direction of the resultant magnetic field of the current and pressure coils depends on the ratio of the currents in them, and as the current in the former is $\frac{E}{r+x}$, where r is resistance of current coil, and x the insulation resistance of the mains; and the current in the pressure coil is simply $\frac{E}{R}$, where R is the total resistance of the pressure coil and its series resistance, we see that the direction of the resultant field depends only on $\frac{r+x}{R}$. The needle system is either astatic or placed in a field reduced nearly to zero by means of a neutralising magnet, so the position of the needle N.S. depends on $\frac{r+x}{R}$. The term r is eliminated in the process of calibration, each division corresponding to $(r+x)$, ohms being marked as x ohms. The position of the needle depends only, therefore, on the ratio $\frac{x}{R}$. As the current coil is traversed merely by the leakage current, its field is very weak, so that it has to be made of several thousand turns and the needle brought as close as possible to it. The ohmmeters usually made to read from five megohms down to 100,000 are ohms on one scale, and the current coil is provided with one or two shunts to continue the range down to 10,000 or 1,000 ohms.

In addition to their use as *ohmmeters*, these sets of testing apparatus completely dispense with the lineman's detector and battery. The generator alone may be most conveniently used for continuity tests during the wiring of houses, &c., by keeping it connected to the main leads; and while it is being driven at a moderate speed, every pair of single-light leads is tested by making contact and noting by the sparking whether the circuit is intact. The whole process is exceedingly quick and certain. A short-circuit at any point of the ramification can also be detected by the severe drag on the generator handle, and by the violent sparking at the commutator.

The whole apparatus is compact, well constructed, and neatly finished off, and should prove an indispensable adjunct to the equipment of anyone engaged in the practical testing of insulation resistances.

BOOKS, &c., RECEIVED.

"Solutions of the Questions on Magnetism and Electricity set at the Intermediate Science and Preliminary Scientific Pass Examinations of the University of London, from 1860 to 1884." By F. W. Levander, F.R.A.S. Second Edition, corrected and enlarged. (London: H. K. Lewis.)

"Electricity in Modern Life." By G. W. de Tunzelmann, B.Sc. (The Contemporary Science Series.) (London: Walter Scott.)

"Absolute Measurements in Electricity and Magnetism." By Andrew Gray, M.A. Second Edition; revised and greatly enlarged. (London: Macmillan and Co.)

Digitized by Google

ON THE HEATING OF CONDUCTORS BY ELECTRIC CURRENTS.*

BY A. E. KENNELLY.

Although the best economical dimensions of a conductor employed to transmit power are determined by Sir William Thomson's law that that portion of the cost rate depending directly upon the cross-sectional area of the conductor should equal the average cost rate of the power it absorbs in its duty, and although, at the existing prices of copper and of power, such a conductor must be very heavily loaded to acquire a dangerously high temperature, yet not only may its limits of safe capacity be strained by occasional pressure, but it is well known that in practice economy is not the only factor that determines a conductor's size, since the necessity, for example, of maintaining a constant difference of potential over an entire network of electric light mains under wide variations of load may sometimes clash with the conditions of economy in their transmission or even of safety in their temperatures.

Notwithstanding the consequent importance of a complete knowledge of the safe carrying capacity in conductors under all practical conditions of service, the subject has not, apparently, received the attention it deserves, and the simplicity of the law which determines the generation of heat in an active conductor seems to have led the complexity of the laws governing the dissipation of that heat, and thus limiting temperature, to have escaped the full notice of practical men. The most important published contributions to the subject appear in two Papers, one by Mr. W. H. Preece, to the Royal Society (see *The Electrician*, February 17 and 24, and April 27, 1888), and the other by Prof. G. Forbes, to the London Institution of Electrical Engineers (see *The Electrician*, April 5, 1884). The former deals principally, however, with the fusing currents of wires for different metals and diameters, while the latter is almost exclusively devoted to the theoretical treatment of the subject. Had the experimental data of Prof. Forbes' Paper been as exhaustive as its mathematical investigation was complete, there would probably have been little left to add or amend from an engineering point of view; but the vital numerical coefficients it adopts are taken from experiments on the emission of heat, which, however accurate and valuable in themselves, are not fairly applicable to the conditions of conducting wires, and which, in their published form, tend rather to conceal than to elucidate the principles underlying the subject. The fact remains that none of the existing text-books or tables up to the present date give with any pretension to accuracy the carrying capacity of wires consistent with safe temperatures, in clearly tabulated form, or any clear conception of the variation the limit undergoes with change of environment—empanelled, free, or out of doors. In addition to this, the rule of the British Board of Trade for installations within doors has been pointed out by Professor Forbes and others to be very uneconomical for small wires, and actually unsafe for wires of a certain, though perhaps unusual, diameter.

To determine some of these unknown quantities, and particularly with a view to obtaining the necessary data for the fire insurance offices, the Edison Electric Light Company, of New York, recently instituted a series of experiments at the laboratory of Mr. T. A. Edison, in Orange, N.J., aud with their permission the results obtained are now published. Not only have satisfactory general rules been arrived at for the safe carrying capacity of conductors, but the numerical coefficients in the formulæ given by Forbes have been determined with a fair practical degree of accuracy, while the field has been opened for further useful investigation.

The experiments were made on conductors under three different conditions:

1. With insulated copper wires encased in wooden panelling to represent house wires.
2. With copper wires, both bare and covered, suspended on poles in the open air to represent overhead service.
3. With copper wires and strips suspended across a room to represent the conductors in an electric light station, and also to form a connecting link between the two previous conditions.

The elevation of temperature produced in the wires (whose conductivity varied from 97 to 101† per cent.) was in every case determined from the increase of their resistance observed after the experimental current had been passed through them sufficiently long to practically attain a limiting permanent temperature. This period of time was found to be about ten minutes with the panelled, and some two minutes with the suspended wires. With the former, a steady increase of resistance, which, according to theory, would continue for all time, could be noticed for as much as 30 minutes, but it was estimated that the temperature elevation reached in 10 minutes was 97 per cent. of its full ultimate value, and the greater accuracy attained by longer intervals of flow would not have repaid greater loss of time, especially as the quality of the wooden panel, its thickness, form and position, would practically involve commensurate variation in results.

It has been sometimes believed that the temperature elevation computed from the rise of resistance would be somewhat in defect, owing to the gradient of temperature from the centre to the circumference, and the cooling of the external surface. Analysis shows, however, that this source of error is too trivial to be taken into account, for if θ be the difference of temperature in degrees Centigrade maintained in the permanent state between the axis of a wire and its exterior, then it will be found that

$$\theta = \frac{\rho}{J\,K}\left(\frac{C}{O}\right)^2;$$

where ρ is the resistivity of the wire,
C is the current it carries,
O is its circumference,
J is Joule's equivalent, or 42 megalergs,
K is the thermal conductivity of the metal,
all being expressed in absolute measure.

For a copper wire of one centimetre in circumference, carrying 100 amperes, with $\rho = 2{,}000$ and $K = 1{\cdot}1$, $\theta = \frac{1}{220}$ of 1°C.

Empanelled Wires.

Two 20-foot lengths of pine panelling were made, and in all the tests these panels rested with their broad bases on the wooden floor of the testing-room. In the smaller size, 12 wires, ranging from 0·0185in. (0·047 centimetre) to 0·119in. (0·302 centimetre) diameter, were successively tested, one side only of the panel being occupied at one time. In the larger size, 12 larger wires were tested, ranging from 0·119in. (0·302 centimetre) to 0·445in. (1·131 centimetres) diameter, generally two at one time, one in each compartment, so that the observations may be said to extend to diameters of nearly half an inch, or from wires whose resistance per metre varied from 0·019 ohm to 245 microhms at 0°C. All the resistances in the tests are expressed in legal ohms (106·0 centimetres).

The increase in the resistance of the wires due to their heating was determined in the cases of all but the very smallest by that very accurate null method, in which the variable potential difference between the ends of the tested wire is balanced against the constant potential difference between the ends of an invariable platinoid resistance in the same main circuit. This standard resistance was formed by the grid of 40 parallel platinoid wires, each eight feet (244 centimetres) long and 0·031 in. (0·079 centimetre) in diameter, stretched in a wooden frame between copper rods. The joint resistance of all these wires was 0·0499 ohm, and their large total surface of 374 sq. in. (2,410 square centimetres) and small coefficient of temperature variation (0·021 per cent. per degree C.) effectually maintained the resistance constant within at least 0·1 per cent. under all current strengths employed, especially as with the stronger currents the grid was connected with its two halves in multiple by letting the current enter at a third copper rod in the centre and divide among the forty wires on each side, the total resistance in this condition being 0·0121 ohm. To balance the potential differences supplied by the wire and the grid, a dead-beat differential mirror galvanometer was employed. It was carefully adjusted for differential perfection, until five volts connected with its coils in opposition series produced a barely perceptible deflection. The resistances and balance of the coils (about 2,700 ohms each) were observed before and after each test. During the observations one of these coils was connected with the panelled wire, and the other in opposition with the platinoid grid. The initial difference between the opposed currents thus acting on the needle when the first feeble current was sent through the main circuit, was reduced to vanishing point by inserting resistance in the circuit of preponderating influence. Under these conditions the resistance of the wire became determined, and its terminal potential difference exactly balanced on the galvanometer that from the grid. As the current in the main circuit was successively increased this balance became upset by the corresponding rise of temperature, resistance, and terminal P D of the wire, necessitating readjustment of the inserted resistance, while the extent of this readjustment supplied all the data for the calculation of the change. This method was found to be very sensitive, and allowed the rise of temperature to be observed in a convenient manner for estimating the approach to limiting permanent state, while all slight variations of the dynamo-testing current were eliminated, since their effect was equal and opposite on the galvanometer circuits. The temperature elevation was carried up to 100°C. except in the case of the largest wires. The strength of the current passing in the main circuit through wire and grid from the laboratory 110-volt dynamo was adjusted by platinoid resistances for the feebler currents, by banks of Edison lamps for the stronger, and by a set of overhead wires for the strongest of all, the limit reached being 300 amperes. It was

* Abstract of Report read before the Edison Convention at Niagara Falls, August, 1889.

† Samples of copper offering a conductivity of as much as 104 per cent. of the original Mathiessen standard are stated to have been produced within the last few years, showing that the value of the standard needs revision under improved forms of chemical and mechanical treatment.

Digitized by Google

measured by means of a potentiometer connected with the grid, and also by at least one ammeter or dynamometer in the main circuit, whose readings were taken as a check upon the former. About one reading of the current per minute was observed, and the mean taken as that of the average current flowing during the period. The potentiometer employed its own working battery, mirror galvanometer and Clark standard cell.

The accompanying diagram (Fig. 1) shows the curves obtained by freely connecting the plotted observations resulting from the whole series of panel measurements. The ordinates represent the temperature elevations and the abscissæ are the current strengths to which those temperature elevations are due. Of the three connected variables, diameter, current strength and rise of temperature, this figure most clearly indicates the relation between temperature and current, while the influence of diameter may be deferred for the moment. It is seen that, generally speaking, the temperature elevation varies as the square of the current strength for any given wire. This would be, perhaps, rigorously true if the resistance of the wire did not increase with temperature, if the conductivity of the panel remained constant, if the space between the wire and the panel walls were filled with solid material, and finally, if the exterior surface of the panel were maintained at the temperature of surrounding bodies. Under existing conditions the wire generates heat, owing to its rising resistance, faster than the square of the current; while, on the other hand, radiation and convection from the external surface are more than proportionally active as the temperature rises, the two deviations thus counteracting to some extent. So that, while the above law cannot be expected to apply accurately, the observations show the departures from it are not so great as to make the rule practically unserviceable. For diameters below 0·10in. (0·25 centimetre) the temperature elevation appears to have risen more slowly than the square of the current, while for diameters above 0·30in. (0·76 centimetre) the opposite tendency is shown.

On plotting the results of Fig. 1 in such a manner as to elicit the dependence of temperature elevation on diameter alone for constant-current strengths, the curves so obtained have not been identified with any simple algebraic law; in fact, the conditions are of so complex a nature as to afford little hope of a simple, yet rigorous, law applying. The loss of heat is taking place, first, by conduction through the insulating covering of the wire, then by conduction, convection, and radiation through the enclosed air space; next by conduction through the woodwork; and finally, into the floor or wall to which the panel is fixed, while radiation and convection carry off the heat from the free surface exposed to the air. Even under the simplest conditions that can be imposed in imagination upon the panel, such as cylindrical form with free access of air all round, and a tight fit upon the wire at the axis, the law of temperature increase with diameter for constant currents would involve the ratio of the panel diameter to the wire's diameter logarithmically, and the various dis-symmetrical but practical conditions can only serve to make the law more complicated. In the absence then of any simple rigorous law, it becomes necessary to select some particular temperature elevation as the safe limit which a wire can be allowed to reach under ordinary conditions, and then to find the best empirical rule which shall approximate as nearly as may be needed to the curve of experimental results.

The rule recommended by the Committee of the London Institution of Electrical Engineers for the prevention of fire risks in electric lighting, as published last year, was that:—"The conductivity and sectional area of any conductor should be so proportioned to the work it has to do that if double the current proposed be sent through it the temperature of such conductor shall not exceed 150° F." With this rule as a guide, the only remaining question is the normal temperature of the wires from which the rise is assumed to take place. A cellar in winter time might have a temperature of 40° F. (4·5° C.), while near the ceiling of an artificially-warmed room the thermometer might reach 100° F. (38° C.) As it would be out of the question to design every wire in a house for the exact temperature it might normally possess at different portions of its length, a fair mean temperature must be selected from which all elevations can be reckoned. This mean temperature may be taken at 75° F. (24° C.). This being admitted, the rule above-mentioned requires that the temperature elevation of any wire shall not, with double the proposed current, exceed 75° F., *i.e.*, reach above 150° F. (41·7° C.), and it has been seen that this is, for practical purposes, equivalent to the statement that the proposed current shall not produce an elevation of one-fourth that amount (10·4° C.).

Fig. 2 shows the general results arranged for the purpose of directly indicating the observed dependence of current strength and diameter for any given temperature elevation. Taking for granted that the 10° C. elevation is that which prescribes the safety limit as above, then the empirical formula which shall best represent the 10deg. curve will form the rule by which the safe diameters of panelled wires may be determined. For the 10° C. curve itself it is difficult to find a simple equation, but for the broken line curve near it, — — —, which follows the current whose double raised the temperature 40° C., the equation: Limiting current in amperes = 560 (diameter of wire in inches) $^{3}/_{2}$, is seen to be closely applicable except for very small wires, the curve — · — · —, in conjunction, being the strict locus of this equation. This formula makes the small wires rather larger than experiment has shown they need be, but it will be seen that even then they are much smaller than the Board of Trade rule requires. The following are then the proposed formulæ for determining the limiting safe currents and diameters for insulated copper wires in wooden panels:—

$C = 560\ d^{\frac{3}{2}}$, if d be expressed in inches;
$= 0{\cdot}01775\ d^{\frac{3}{2}}$, if d ,, ,, mils;
$= 138\ d^{\frac{3}{2}}$, if d ,, ,, centimetres;
$= 4{\cdot}375\ d^{\frac{3}{2}}$, if d ,, ,, millimetres.

And reciprocally,

$d = 0{\cdot}0147\ C^{\frac{2}{3}}$, if d be expressed in inches;
$= 14{\cdot}7\ C^{\frac{2}{3}}$, if d ,, ,, mils;
$= 0{\cdot}0374\ C^{\frac{2}{3}}$, if d ,, ,, centimetres;
$= 0{\cdot}374\ C^{\frac{2}{3}}$, if d ,, ,, millimetres.

For ordinary purposes it is convenient to remember that when d is expressed in inches and C in amperes, $d = \frac{\sqrt[3]{C^2}}{70}$.

From these data we have the following table giving in inches and centimetres the diameter of insulated copper wire necessary for any specified current:

Amperes.	Minimum safe diameter of copper wire.		Circular mils per ampere.	Fall of potential in wire at full load.	
	Inches.	Cms.		Volts per foot.	Volts per metre.
1.....	·015	·038	225	·0503	·165
5.....	·432	·109	370	·0305	·100
10.....	·069	·175	480	·0237	·0777
15.....	·090	·239	540	·0208	·0681
20.....	·109	·277	590	·0189	·0621
25.....	·126	·320	640	·0177	·0581
30.....	·142	·361	670	·0167	·0548
35.....	·158	·401	710	·0158	·0518
40.....	·172	·437	740	·0152	·0499
45.....	·186	·472	770	·0147	·0481
50.....	·200	·508	800	·0141	·0461
55.....	·213	·541	825	·0136	·0447
60.....	·225	·572	845	·0133	·0437
65.....	·238	·605	870	·0129	·0423
70.....	·250	·635	890	·0126	·0413
75.....	·262	·655	915	·0123	·0403
80.....	·274	·696	940	·0120	·0393
85.....	·285	·724	960	·0118	·0386
90.....	·296	·752	970	·0116	·0379
95.....	·307	·780	990	·0113	·0372
100.....	·318	·808	1010	·0111	·0365
110.....	·339	·861	1040	·0108	·0353
120.....	·358	·909	1070	·0105	·0346
130.....	·377	·958	1090	·0103	·0337
140.....	·396	1·01	1120	·0099	·0327
150.....	·415	1·05	1150	·00975	·0320
175.....	·461	1·17	1210	·00929	·0305
200.....	·504	1·28	1270	·00887	·0291
225.....	·545	1·38	1320	·00853	·0280
250.....	·585	1·49	1370	·00817	·0268
275.....	·623	1·58	1410	·00798	·0262
300.....	·660	1·68	1450	·00771	·0253
325.....	·697	1·77	1490	·00753	·0247
350.....	·732	1·86	1530	·00734	·0241
375.....	·766	1·95	1570	·00716	·0235
400.....	·800	2·03	1600	·00714	·0231
425.....	·832	2·11	1630	·00692	·0227
450.....	·865	2·20	1660	·00674	·0221
475.....	·897	2·28	1690	·00665	·0218
500.....	·928	2·36	1720	·00652	·0214
550.....	·988	2·51	1775	·00634	·0208
600.....	1·049	2·66	1840	·00616	·0202
700.....	1·16	2·95	1920	·00585	·0192
800.....	1·27	3·23	2020	·00558	·0133
900.....	1·37	3·48	2080	·00539	·0177
1000.....	1·47	3·73	2160	·00521	·0171

DATA.—Insulated house wires carrying continuous currents, and encased in wooden panelling. Copper resistivity: 1·650 microhms @ 0°C. = 1·870 microhms @ 34°C. assumed temperature of full load. Conductivity allowed 98 per cent.

This table shows that whatever temperature elevation might be adopted as the safety limit, the principle of fixing upon the diameters of conductors by allowing a certain number of amperes to the square inch, or a certain number of circular mils to the ampere,

Digitized by Google

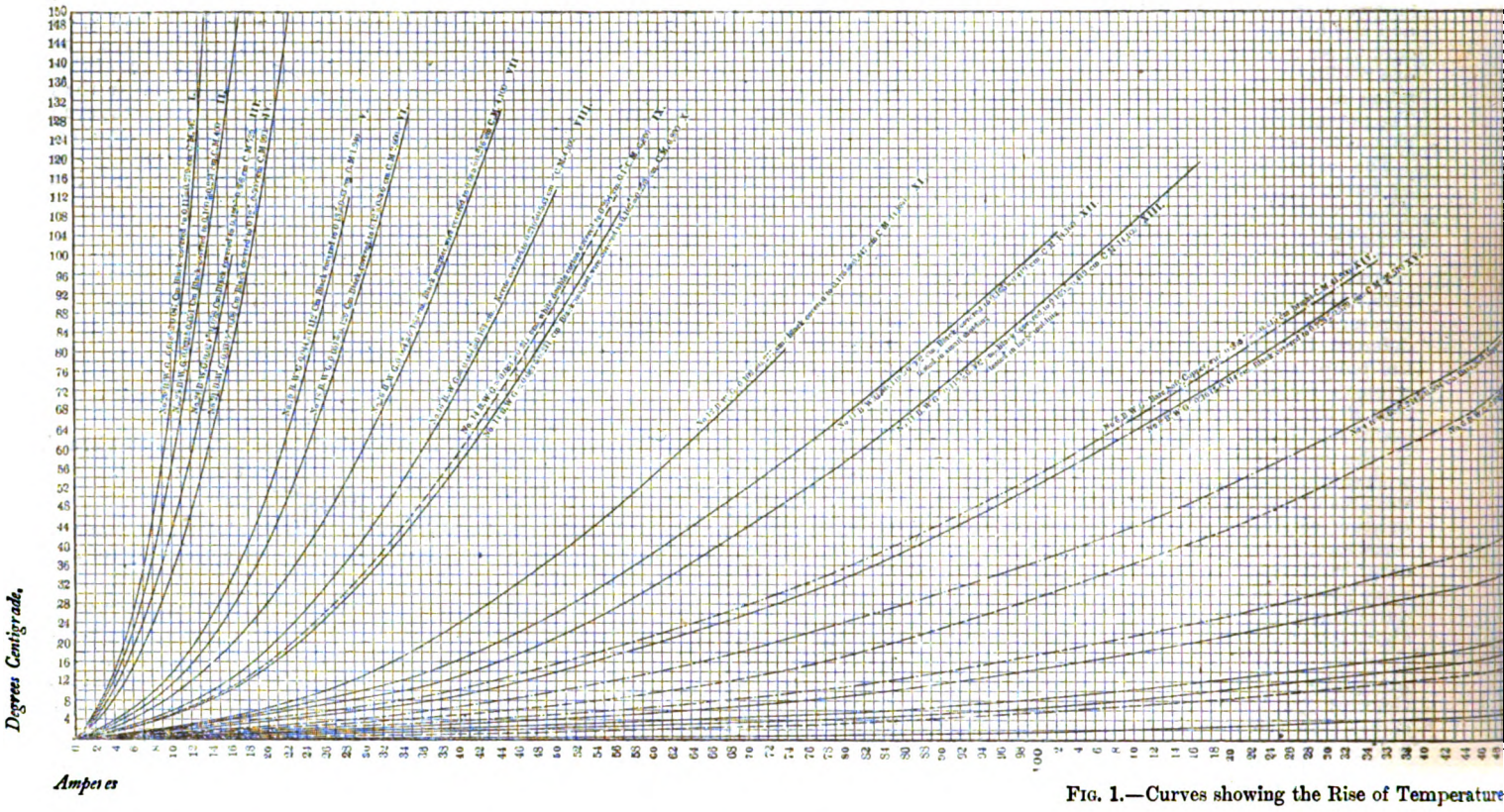


FIG. 1.—Curves showing the Rise of Temperature

can only be very imperfect unless a sliding scale be arranged. Thus the diameter of wire which coincides with the Board of Trade limit of 1,000 amperes per square inch is 0·504 inch for 200 amperes. at 1,000 amperes per square inch requires 508,000 circular mils, or a diameter of 0·713in., while the table indicates 0·800in. ; and, on the other hand, to carry 40 amperes the same rule calls for 0·225in., the table showing only 0·172in. to be necessary. For the same reason, when the space occupied by the wires is no object, there is always an economical limit to the size of the main in any house installation, for if the fall of potential permissible in them reduces their selection to pure considerations of safety, then it will always be more economical to subdivide the conductors for heavy currents. For example, if 500 amperes have to be carried at full load, the table indicates a main of 0·928 inches (2·36 centimetres) in diameter. But by taking two equal mains each, carrying 250 amperes, their diameters will be 0·585 in. (1·49 centimetres) and the weight of copper will be reduced rather more than 20 per cent. ; and in all cases, whenever 20 per cent. of the cost of copper necessary for one main will more than cover the expense of another insulating covering and panelling for the second wire, there being no independent objections, it will be economical to divide the conductor. This remark is, of course, not merely a deduction from the table, nor in any way implicated with the limiting temperatures on which it is based, but is founded on the fact that when a wire's diameter is

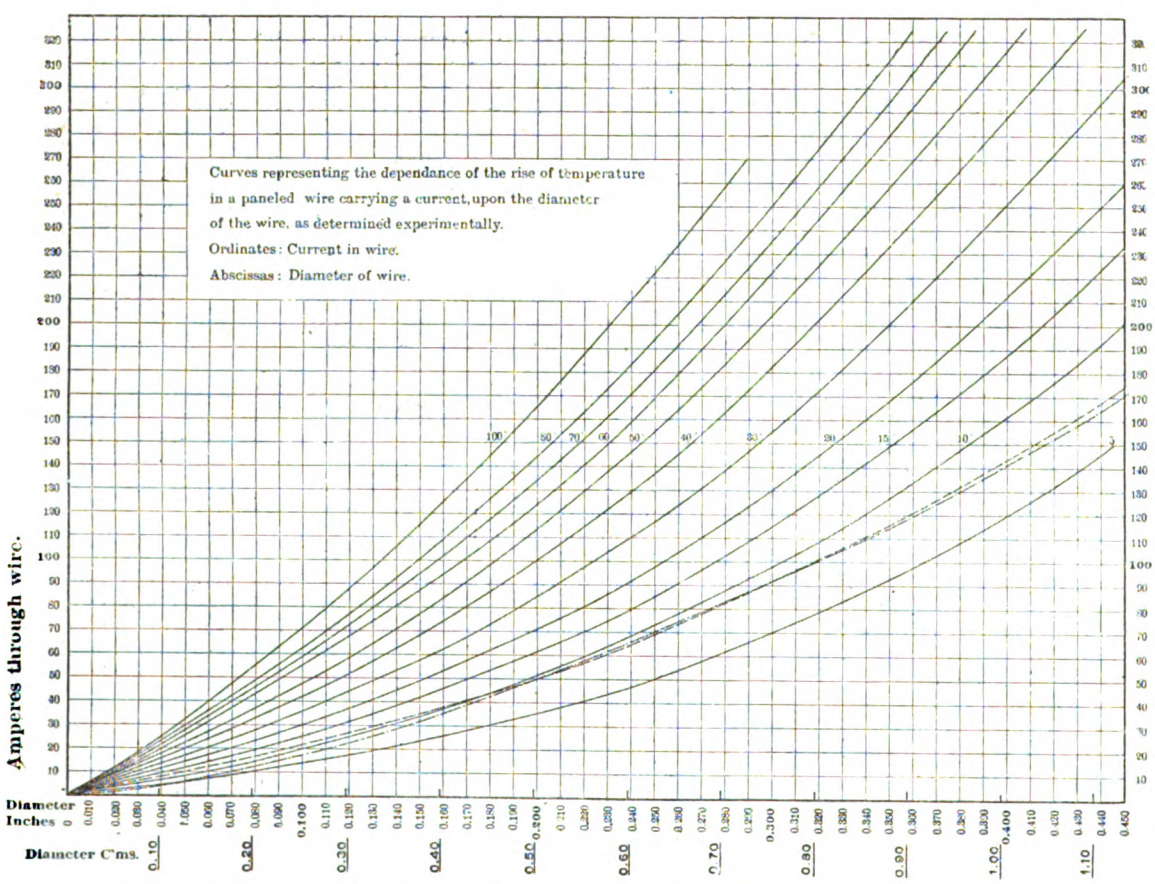
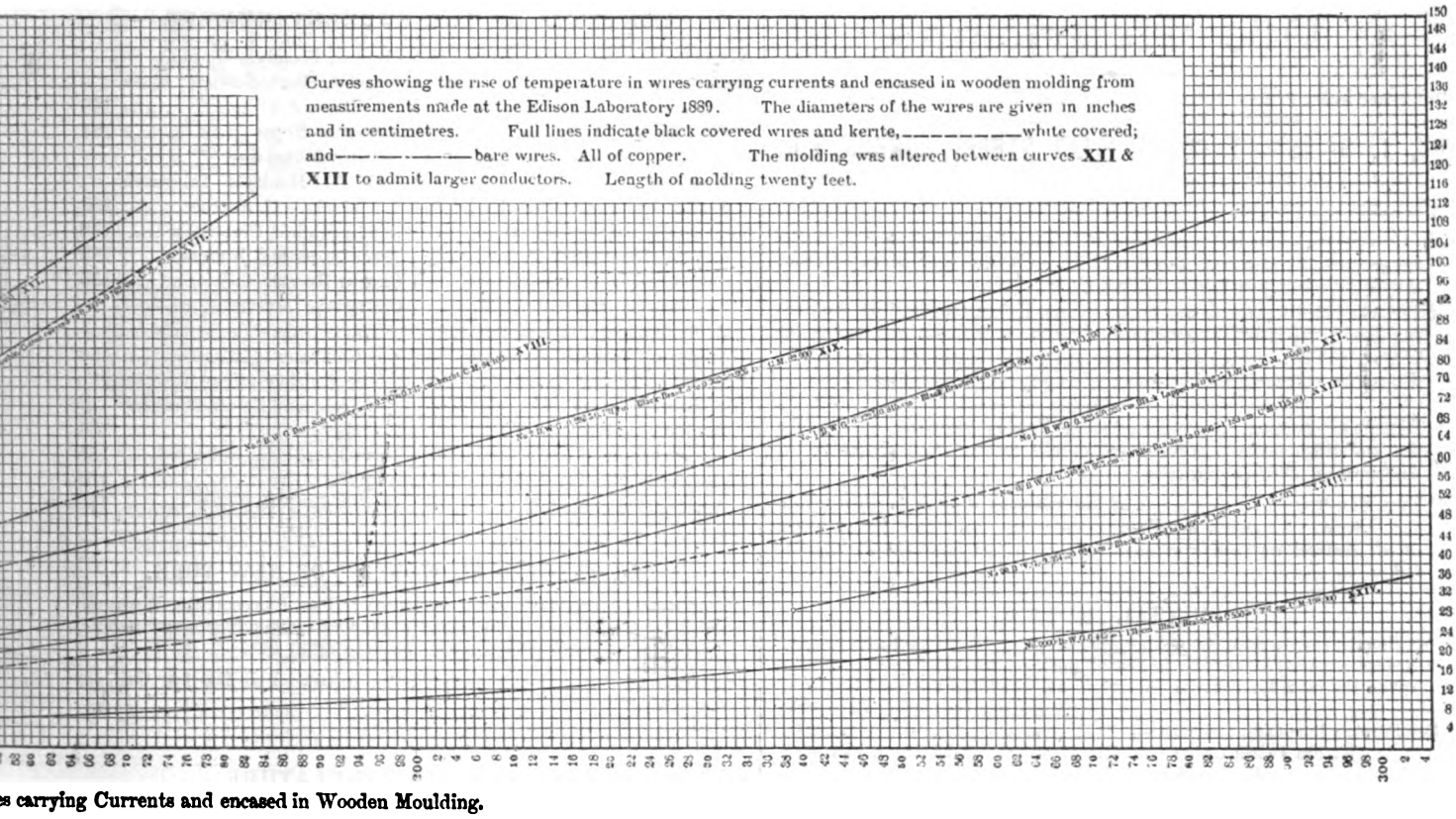

Curves representing the dependance of the rise of temperature
in a paneled wire carrying a current, upon the diameter
of the wire, as determined experimentally.
Ordinates: Current in wire.
Abscissas: Diameter of wire.
Amperes through wire.
Diameter Inches
Diameter C'ms.

FIG. 2.—Curves representing the Dependence of the Rise of Temperature in Wires upon their Diameter.

According to the table, that rule would not be safe for wires above that diameter, while for wires beneath that diameter it would, in respect to safety, be very economical. Thus, to carry 400 amperes

Digitized by Google


Curves showing the rise of temperature in wires carrying currents and encased in wooden molding from measurements made at the Edison Laboratory 1889. The diameters of the wires are given in inches and in centimetres. Full lines indicate black covered wires and kerite, ———— white covered; and —— — —— bare wires. All of copper. The molding was altered between curves XII & XIII to admit larger conductors. Length of molding twenty feet.

s carrying Currents and encased in Wooden Moulding.

doubled, although it takes twice as strong a current to develop the same heat as before per unit volume, there will be four times as much total heat and only twice as much surface through which that heat has to find egress.

Referring to the general curve sheet, certain deductions may be made from it concerning the effect of the nature and thickness of insulating covering, and also the influence of the panel dimensions. The evidence is distinct that, with all the wires tested, and which had the usual thickness of insulating covering [about 0·050in. (0·13 centimetre) for the small and large wires, with about 0·035in. (0·09 centimetre) for the intermediate sizes], the effect of the insulation covering was to cool the wire. Thus, curves Nos. XIV., XVI., and XVIII. (Fig. 1) represent the observations on bare copper wires, and show that their temperature elevations were fully 30 per cent. in excess of that found in covered wires of equal diameter and load. Again, curve No. VIII. refers to a kerite wire whose coating was 0·073in. (0·185 centimetre) thick. Its temperature elevation is seen to have been about 30 per cent. lower than that obtained with a wire of the same diameter but only covered to a thickness of 0·011in. (0·028 centimetre), No. VII.

As regards the surface nature of the insulating material, curves Nos. IX. and X. represent the behaviour of two wires whose diameters and thickness of insulation were practically equal. No. IX. was double covered with white cotton; No. X. single covered with blackened cotton. All the ordinary insulated house wires were covered at the Edison Machine Works, Schenectady, N. Y., with cotton soaked in a special insulating liquid. The temperature elevation of the latter was about 4 per cent the lower, and while it is possible that this difference may have been due to the superior radiating power of the black coating, it is not sufficiently marked to be more than a possibility. Curves Nos. XII. and XIII. show the temperature elevations of the same length of wire first in the smaller panelling and then in the larger. In the latter case there is a cooling effect visible, amounting to 10 per cent.

The conclusion rests that while the exact temperature elevations of a panelled wire depends upon a variety of factors, it is capable of being fairly estimated from the average of a number of experiments under actual conditions, and care has been taken to obtain these measurements under as nearly practical conditions as possible. The mean conductivity of the wires was about 99 per cent.; that is to say, a mean resistivity of 1,640 absolute legal units. The temperature coefficient has been taken at $1+0{\cdot}00388\,t$, t being the elevation in degrees Centigrade. In applying the rule for safety limitation as given by the table, insulated wires are, of course, to be understood, and no particular thickness or quality of insulation need then be specified. For although extra thick insulating covering cools the wire, it would not be desirable to render it specially thick merely with that object in view. Also each wire should have its own groove, or, if several wires are in the same channel, the total area and surface of the woodwork should be correspondingly large. Finally, the panelling should be run as far as possible through places not exposed to an abnormally high temperature.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-night) FRIDAY, December 13th.

INSTITUTION OF CIVIL ENGINEERS.

7:30 p.m. Students' Meeting. Paper to be read, "Hydraulic Station and Machinery of the North London Railway, Poplar." By JOHN HALE, Stud.Inst.C.E.

MONDAY, December 16th.

LONDON INSTITUTION.

5 p.m. Lecture: "Lustre Decoration in Ceramic Art." By HENRY WALLIS.

SOCIETY OF ARTS.

8 p.m. CANTOR LECTURE I. 4. "Modern Developments of Bread-Making." By WILLIAM JAGO.

TUESDAY, December 17th.

ROYAL VICTORIA HALL.

8:30 p.m. Lecture: "My Experiences in Cape Colony." By Prof. H. G. SEELEY.

WEDNESDAY, December 18th.

ROYAL METEOROLOGICAL SOCIETY.

7 p.m. Ordinary Meeting. Papers to be read:—"Report of the Wind Force Committee on the Factor of the Kew Pattern Robinson Anemometer." Drawn up by W. H. DINES, B.A., F.R.Met.Soc. "On Testing Anemometers." By W. H. DINES, B.A., F.R.Met.Soc. "On the Rainfall of the Riviera." By G. J. SYMONS, F.R.S. "Report on the Phenological Observations for 1889." By EDWARD MAWLEY, F.R.Met.Soc.

CIVIL AND MECHANICAL ENGINEERS' SOCIETY.

7 p.m. Ordinary Meeting. Paper to be read, "Percussive Rock Drilling Machinery." By R. BOLTON.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Paper to be read, "London Sewage." By Sir ROBERT RAWLINSON, K.C.B.

THURSDAY, December 19th.

LONDON INSTITUTION.

6 p.m. Lecture: "The Optical Properties of Gems and Precious Stones." By Prof. SILVANUS P. THOMPSON, D.Sc.

Digitized by Google

The Electrician.

Published every Friday. Price Fourpence; Post Free, Fourpence Halfpenny.
Editorial, Publishing and Printing Offices:
No. 1, SALISBURY COURT, FLEET STREET, LONDON, E.C.
Telephone No. 2714. *Telegrams:* "ELECTRICIAN NEWSPAPER, LONDON."

All Communications to be addressed to "THE ELECTRICIAN," *1, Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN."

All letters intended for insertion in "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. Subscribers should receive their copies by the first post on Friday morning.*

"THE ELECTRICIAN" *is on sale at the railway bookstalls throughout the United Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices as above.*

SPECIAL NOTICE.

Owing to the increase in the number of pages of "THE ELECTRICIAN," in order to partly cover the increased postage, we have been compelled to revise the rates for Foreign Subscriptions, which are now as follows:—

	3 months.	6 months.	12 months
For Foreign Parts and Colonies:—	s. d.	s. d.	s. d.
Within Postal Union	6 6	12 6	24 0
Aden, Borneo, Ceylon, China, India, Japan, Java, Labuan, Mozambique, New Caledonia, Persia, Philippine Islands, Siam, Transvaal, and Zanzibar	7 6	14 6	28 0
The rates for the United Kingdom remain as follows:—	5 0	10 0	19 6

TO ADVERTISERS.

"THE ELECTRICIAN" *offers exceptional advantages to Advertisers.* **It has the largest circulation of any English Electrical paper, and circulates all over the World.**

Particulars relating to Advertisements will be promptly forwarded on application to the office.

TRADE ADVERTISEMENTS *intended for the current issue must be handed in not later than First Post on Thursday morning.*

SMALL PREPAID ADVERTISEMENTS *(for Rates see page xiii.) are accepted up to 4:30 p.m. on Thursday.*

TECHNICAL PRINTING.

"THE ELECTRICIAN" PRINTING AND PUBLISHING COMPANY (LIMITED) *beg to inform Electricians, Electric Light Engineers, &c., that they make a specialty of Technical Printing, and have a Staff thoroughly acquainted with Electro-Technology. They can, therefore, promise Accuracy and Despatch in the Printing of Electrical Catalogues and Electro-Technical Literature generally.*

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.

Royal 8vo.

Early in each year is issued "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK. *The* DIRECTORY *was established in 1883, and the 1889 Edition, which is now on sale, consists of more than 600 pages of printed matter. Every care is taken to make the names and addresses of all persons engaged in the Electrical Industries absolutely accurate. Useful Tables and Electrical Formulæ are given, together with popularly-written Biographical Notices of the leading Electricians, Electrical Engineers, &c., accompanied in many cases by Portraits.*

The issue for 1890, which will be still further enlarged and improved, is in active preparation. New Names and Addresses, Corrections, Advertisements, &c., should be forwarded at once to the Publishing Office, **1,** *Salisbury-court, Fleet-street, London, E.C.*

CONTENTS OF THE CURRENT NUMBER.

NOTES 131
Reviews 136
A Comparison between the Continental, American, and English Dynamo-Electric Machinery. By Albion T. Snell. Illus. Concluded ... 138
The Goolden-Evershed Ohmmeter. Illustrated 141
On the Heating of Conductors by Electric Currents. By A. E. Kennelly. Illustrated. 142
Meetings of Scientific Societies. 145
ELECTRICAL NOMENCLATURE ... 146
The Institution of Electrical Engineers.—Election of Officers and Council for 1890 ... 148
"Electrical Engineering in America." Concluded..... 148
Physical Society—
"The Electrification of a Steam Jet" 149
American Notes 151
CORRESPONDENCE—
W. T. Henley's Telegraph Works.—G. Sutton 152
The Smithfield Club Show 152
Trade Notes and Notices 153
PATENT RECORD 153
COMPANIES' MEETINGS, &c.—
The Fowler-Waring Cables Company (Limited)..... 154
The Gülcher (New) Electric Light and Power Company (Limited)..... 154
New Companies Registered ... 155
City Notes, &c..... 155
Companies' Share List 156

"THE ELECTRICAL WORLD" OF NEW YORK.

Arrangements have been made by which "THE ELECTRICAL WORLD" OF NEW YORK *can be obtained from* "THE ELECTRICIAN" *Office, 1, Salisbury-court, Fleet-street, London, E.C.*

The Rate of Subscription (payable in advance), is **£1 1s. 0d.** *per annum.*

ELECTRICAL NOMENCLATURE.

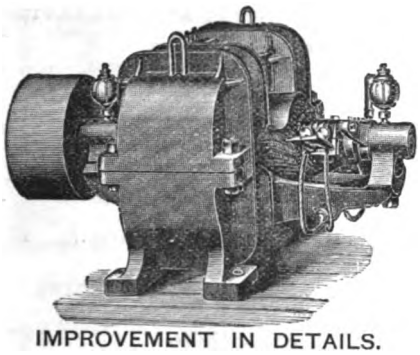
We recently commented upon some portion of our correspondence which raised questions concerning the appropriate name and magnitude of the unit of self-induction. In returning again to the subject there are, however, some general questions in connection with the subject of electrical nomenclature which it may not be inappropriate to discuss. The nomenclature of every science, like a poet, is born and not made. It has to grow and develop by a process of evolution, and does not depend on arbitrary decrees. We remember that in some of his writings, Mr. HERBERT SPENCER has pointed out how the commonest actions of modern daily life, such as shaking hands or raising the hat in saluting, have been evolved from actions having very definite significations in the life of ruder times. The precise nomenclature of science develops in like evolutionary manner, and it is impossible to produce a sudden discontinuity in this process. In order that a term or word shall be assimilated uniformly and thoroughly into the usage of everyday life in technical matters, it is essential that it shall meet a general want which has made itself felt prior to the advent of the term. It does not, however, follow that the first attempts to build up the nomenclature of a science make more than an initial approach to naming that which requires to be named. In many cases names or terms primarily cover ignorance, and, in so far as they have only an appearance of knowledge, and are destitute of perfectly clear meaning, they may be a hindrance instead of an assistance at a further stage of knowledge. Prof. HUXLEY is reported to have once said that if he met with the word *polarity* in a book not having reference to physics, he read no more of it. We might instance such terms as *polarisation* and *catalytic action*, employed by some writers in physics and chemistry, as terms of a similar kind which cover great amounts of ignorance.

The first attempts to form the nomenclature of a science generally result in terms and words which suggest or contain too much hypothesis. In some respects the progress of science may be said to consist in making our words mean less and less—that is to say, depriving them of hypothesis and employing them to denote simply observed facts or

Digitized by Google

LAURENCE, PARIS & SCOTT, Ltd.

Gothic Works, King St., NORWICH.

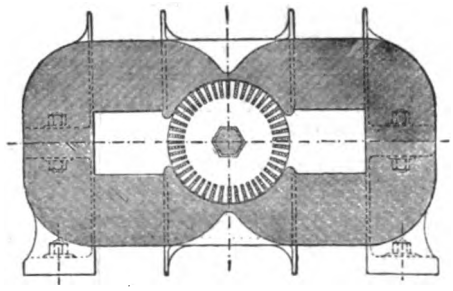


IMPROVEMENT IN DETAILS.

THE MOST RELIABLE AND THE CHEAPEST

Dynamos & Motors.

EQUAL IN EFFICIENCY AND SUPERIOR IN MECHANICAL CONSTRUCTION TO ANY IN THE MARKET.



PERFECT MECHANICAL CONSTRUCTION.

THE GENERAL ELECTRIC CO., Ltd. (G. BINSWANGER, Managing Director)

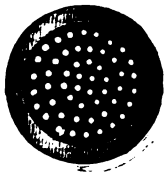
(OF LONDON AND MANCHESTER)

TELEGRAMS "ELECTRICITY." 71, Queen Victoria Street, LONDON, E.C. [TELEPHONE No. 1887

MANUFACTURERS AND SUPPLIERS OF ALL ELECTRIC LIGHT FITTINGS AND MATERIAL.

BEST. CHEAPEST.

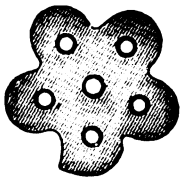
"APOSTLE" ELECTRIC LIGHT CARBONS.



Lead Covered Cables, Anti-Induction and Bunched for Underground, Submarine and Aerial, Telephone, Telegraph, Electric Light, and Power.

THE FOWLER-WARING CABLES COMPANY, LTD.

85, QUEEN STREET, LONDON, E.C.



F. WIGGINS & SONS, Telephone No. 2248. } 10, Tower Hill, E., and 102, Minories, London, E.C.

Manufacturers of MICA GOODS for PHILOSOPHICAL and ALL PURPOSES.

CONTRACTORS TO HER MAJESTY'S GOVERNMENT.

MICA

ELECTRIC TRAM-CARS.

33,000 MILES ALREADY RUN.

Daily Average 300 Miles.

Running for the

NORTH METROPOLITAN TRAMWAYS CO., LTD.,

ON THE BARKING ROAD, E.

Everyone should see these Cars. Certain to supplant horse and other form of traction. Full particulars from the SECRETARY,

ELECTRIC TRACTION CO., Ltd., New Broad Street House, London, E.C.

Digitized by Google

"THE ELECTRICIAN" INDEX TO ADVERTISERS.

Advertisers in "The Electrician" have their names inserted under the following headings in this Index FREE OF CHARGE.

ACCUMULATORS. PAGE
Drake and Gorham ..... —
Electrical Power Storage Co. .. 20
ACIDS.—Berk (F. W.) and Co. 18
ALTERNATORS.
Brush Electrical Eng. Co. (Ltd.).. 6
Johnson and Phillips 1
AMMETERS.
Acme Electric Works 18
Goolden (W. T.) and Co..... 11
Nalder Bros. and Co. 8
Sharp and Kent..... 12
ANTI-FOULING COMPOSITIONS.—Kirkaldy (J.) and Son. 19
ARC LAMP BLOCKS.
Joyner (Chas.) and Co. ..... —
ASBESTOLINE.
Bell's Asbestos Company 24, 25
AUCTIONEERS AND VALUERS (Mechanical).
Wheatley Kirk, Price and Goulty 3
B.A. SCREW THREAD.
Lehmann (Th.) 8
BATTERIES.
Fowler, Lancaster and Co..... 3
Gent and Co. ..... —
India Rubber & Gutta Percha Co. 14, 18
Johnson and Phillips 1
Laing, Wharton and Down 9, 17
Latimer Clark, Muirhead & Co. 1
BATTERY JARS.
Joseph Bourne and Son 17
Cannington, Shaw and Co..... 2
Gent and Co. ..... —
Price, Sons and Co. ..... —
Stiff (J.) and Sons 8
BELTING.
Balderston and Co. ..... —
Moseley and Sons..... —
Thompson (N. G.)..... —
Willcox (W. H.) and Co..... —
BRIDGES (WHEATSTONE).
Woodhouse & Rawson United, Ltd 7
CABLE COMPANIES.
African Direct Telegraph Co. .. 26
Anglo-American Telegraph Co. 29
Brazilian Submarine Tel. Co. .. 27
Direct United States Co..... 29
Eastern Telegraph Co..... 30
Eastern Extension Telegraph Co. 30
Eastern & South African Tel. Co. 26
Indo-European Co. 28
West African Telegraph Co..... 26
Western and Brazilian Tel. Co... 27
CABLE SUPPLIES.
Latimer Clark, Muirhead & Co... 1
Elliott Brothers 19
Felten and Guilleaume 1
Fowler-Waring Cables Co. (Ltd.) 15, 19
W. T. Glover and Co. 17
W. T. Henley's Teleg. Works Co. 1
India Rubber & Gutta Percha Co. 14, 18
Johnson (R.) and Nephew ..... —
Johnson and Phillips 1
Pirelli and Co. 2
Telegraph Manufacturing Co. .. 2
M. Theller and Sons 3
CARBONS.
Brush Electrical Eng. Co. (Ltd.).. 6
General Electric Co. 15
India Rubber & Gutta Percha Co. 14, 18
Johnson and Phillips 1
Laing, Wharton and Down 9, 17
Thompson (N.G.) (Carré) ..... —
Woodhouse & Rawson United, Ltd. 7
CASINGS.
Acme Electric Works 18
Garrard (Robert) and Co. ..... —
McGaw and Co. 21
CONDUITS.—Johnson & Phillips 1
CUT-OUTS.
Acme Electric Works 18
Dorman and Smith 17
General Electric Co. 15
Laurence, Paris and Scott (Ltd.) 15, 17
Wolverhampton Electrical Co... 10
Wood (W.) and Co. ..... —
Woodhouse & Rawson United, Ltd. 7
DISINFECTANTS.—Sanitas Co. 18
DYNAMO BRUSHES.
F. H. Royce and Co..... 3
DYNAMO MANUFACTURERS.
Allen and Co. ..... —
Brush Electrical Eng. Co. (Ltd.).. 6
Latimer Clark, Muirhead & Co.. 1
Crompton and Co. (Limited).... 14
Edison & Swan United Elec. Lt. Co. 5
Fowler, Lancaster and Co..... 3
Gülcher Electric Lt. & Power Co. 10
W. T. Henley's Teleg. Works Co. 1
Holmes (J. H.) and Co. 4
M. Immisch..... —
India Rubber & Gutta Percha Co. 14, 18
Johnson and Phillips 1
Laing, Wharton and Down 9, 17
Laurence, Paris and Scott (Ltd.) 15, 17
Paterson and Cooper 17
Sharp and Kent..... 12
Statter and Co. 17
Telegraph Manufacturing Co. .. 2
Thompson (N. G.)..... —
United Electrical Engineering Co. 156
Western Electric Co. 11
Zöpke (F.)..... 8
EBONITE & VULCANITE. PAGE.
Harburg India-Rubber Comb Co. —
D. Moseley and Sons ..... —
EDUCATIONAL.
School of Electrical Engineering 11
ELECTRIC BELLS.
Acme Electric Works 18
General Electric Co. 15
Gent and Co. ..... —
India Rubber & Gutta Percha Co. 14, 18
Johnson and Phillips 1
King, Mendham and Co. ..... —
London Electric Wire Co. 17
Julius Sax 17
Sheppard, Allarton & Madeley.. 8
Telegraph Manufacturing Co. .. 2
Western Electric Co. 11
Woodhouse & Rawson United, Ltd. 7
ELECTRIC LIGHT.
Bernstein Electric Lamp Co..... 2
Brush Electrical Eng. Co. (Ltd.).. 6
Latimer Clark, Muirhead & Co. 1
Crompton and Co. (Limited).... 14
Drake and Gorham..... —
Edison & Swan United Elec. Lt. Co. 5
Electrical Power Storage Co. .. 20
Fowler, Lancaster and Co..... 3
Gent and Co. ..... —
Gülcher Elec. Light & Power Co. 10
W. T. Henley's Teleg. Works Co. 1
India Rubber & Gutta Percha Co. 14, 18
Johnson and Phillips 1
King, Mendham and Co. ..... —
Laing, Wharton and Down (Thomson-Houston) 9, 17
Paterson and Cooper 17
Statter and Co. 17
United Electrical Engineering Co. 156
Woodhouse & Rawson United, Ltd. 7
ENGINEERS & CONTRACTORS
Acme Electric Works 18
Bernstein Electric Lamp Co.... 2
Blenheim (W.) and Co. ..... —
Booth, Ellson and Co. 13
Brush Electrical Eng. Co. (Ltd.).. 6
Latimer Clark, Muirhead & Co. 1
Chamberlain and Hookham 10
Crompton and Co. (Limited).... 14
Drake and Gorham ..... —
Edison & Swan United Elec. Lt. Co. 5
Electrical Power Storage Co. .. 20
Fowler, Lancaster and Co..... 3
W. T. Henley's Teleg. Works Co. 1
India Rubber & Gutta Percha Co. 14, 18
Johnson and Phillips 1
King, Mendham and Co. ..... —
Laing, Wharton and Down ... 9, 17
Laurence, Paris and Scott (Ltd.) 15, 17
Nalder Bros. and Co. 8
Paterson and Cooper 17
Phillips Bros. 17
Julius Sax 17
Sharp and Kent 12
Shippey Brothers (Limited) 10
Starnes (J. S.) and Sons 8
M. Theller and Sons 3
Thompson (N. G.)..... —
United Electrical Engineering Co. 156
Verity (B.) and Sons 21
Westinghouse Electric Company 2
Woodhouse & Rawson United, Ltd. 7
ENGINE PACKING.
Bell's Asbestos Company 24, 25
Starnes (J. S.) and Sons 8
Willcox (W. H.) and Co..... —
ENGINES.
Bailey (W. H.) and Co. (Limited) 12
Bumsted, F. D. 21
Crossley Bros. 22
Davey, Paxman and Co. 14
Marshall, Sons and Co..... 3
Priestman Bros. (Limited)..... —
Ransomes, Sims and Jefferies .. —
Richards and Co. ..... —
Robey and Co. 4
Statter and Co. 17
Willans and Robinson..... —
EXCESS ALARMS.
Drake and Gorham ..... —
EXPANSION SHEETING AND RINGS.
Bell's Asbestos Company 24, 25
FENCING.—R. Johnson & Nephew —
FIBRE.—Moseley (D.) and Sons .. —
FIRE RISKS.—Phœnix Fire Office —
FITTINGS for ELECTRIC LIGHT
Acme Electric Works 18
Crompton and Co. (Limited).... 14
Dorman and Smith 17
Evered and Co. (Limited) ..... —
General Electric Co. 15
Gent and Co. ..... —
Gülcher Elec. Light & Power Co. 10
Johnson and Phillips 1
King, Mendham and Co. ..... —
Laing, Wharton and Down.....9, 17
Telegraph Manufacturing Co. .. 2
United Electrical Engineering Co. 156
Verity (B.) and Sons 21
Western Electric Co. 6
Wolverhampton Electrical Co... 10
Wood (W.) and Co. ..... —
Woodhouse & Rawson United, Ltd. 7
Zöpke (F.)..... 8
FUSES.
Fowler, Lancaster and Co. 3
GLASSWARE.
Acme Electric Works 18
GALVANOMETERS. PAGE.
Nalder Bros. and Co. 8
GAS LIGHTERS (ELECTRIC).
General Electric Co. 15
King, Mendham and Co. ..... —
Woodhouse & Rawson United, Ltd. 7
GLOBES.—Fowler, Lancaster & Co. 3
GYROMETER (Speed Indicator).
Bailey (W. H.) and Co. (Limited) 12
INDIA RUBBER.
Moseley (D.) and Sons..... —
Pirelli and Co. 2
INFLUENCE MACHINES.
King, Mendham and Co. ..... —
INSTRUMENTS.
Acme Electric Works 18
Latimer Clark, Muirhead & Co. 1
Crompton and Co. (Limited).... 14
Elliott Brothers..... 19
General Electric Co. 15
India Rubber & Gutta Percha Co. 14, 18
Johnson and Phillips 1
King, Mendham and Co. ..... —
Nalder Bros. and Co. 8
Paterson and Cooper..... 17
Sharp and Kent 12
Statter and Co. 17
Telegraph Manufacturing Co. .. 2
M. Theller and Sons 3
Woodhouse & Rawson United, Ltd. 7
INSULATION.
Aspinall's Enamel ..... —
Johnson and Phillips 1
INSULATORS.
Joseph Bourne and Son 17
Latimer Clark, Muirhead & Co. 1
W. T. Henley's Teleg. Works Co. 1
India Rubber & Gutta Percha Co. 14, 18
Johnson and Phillips 1
Price, Sons and Co. ..... —
Stiff (J.) and Sons 8
Telegraph Manufacturing Co. .. 2
IRON ROOFS & BUILDINGS.
Fredk. Braby and Co. (Ltd.) 23
Francis Morton & Co. ..... —
IVORY LABELS.
Endolithic Ivory Co. 13
JABLOCHKOFF'S DISTRIBUTION PATENT 156
LAMPS.
Aron Brothers 13
Bernstein Elec. Lamp Co. (Inc.).. 2
Brush Electrical Engineering Co. (Ltd.) (Arc and Incandescent). 6
Crompton and Co. (Limited).... 14
Dorman and Smith 17
Edison & Swan United Electric Light Co. (Incandescent) 5
Fowler, Lancaster and Co..... 3
Gülcher Electric Lt. & Power Co. 10
Holmes (J. H.) and Co..... 4
Johnson and Phillips (Arc) 1
Laing, Wharton & Down (Edison & Swan) 9, 17
Statter and Co. (Arc) 17
Sunbeam Lamp Co. 4
United Electrical Engineering Co. 156
Western Electric Co. (Arc)..... 6
Wolverhampton Electrical Co... 10
Woodhouse & Rawson United, Ltd. 7
Zöpke (F.)..... 8
LIGHTNING CONDUCTORS.
Gent and Co. ..... —
Johnson and Phillips 1
King, Mendham and Co. ..... —
Julius Sax 17
LUBRICANT.
Bell's Asbestos Company 24, 25
Willcox (W. H.) and Co..... —
MANUFACTURING ELECTRICIANS.
Acme Electric Works 18
Latimer Clark, Muirhead & Co.. 1
Dorman and Smith 17
Drake and Gorham ..... —
Elliott Brothers..... 19
General Electric Co. 15
Gent and Co. ..... —
W. T. Henley's Teleg. Works Co. 1
India Rubber & Gutta Percha Co. 14, 18
Johnson and Phillips 1
King, Mendham and Co..... —
Nalder Bros. and Co. 8
Paterson and Cooper..... 17
Julius Sax 17
Telegraph Manufacturing Co. .. 2
M. Theller and Sons 3
United Electrical Engineering Co. 156
Westinghouse Electric Company 2
Woodhouse & Rawson United, Ltd. 7
MEDICAL APPARATUS.
General Electric Company..... 15
METERS (ELECTRICITY).
Chamberlain and Hookham 10
MICA.—F. Wiggins and Sons 15
MOTORS (ELECTRIC).
Brush Electrical Eng. Co. Ltd.).. 6
Cuttriss and Co. ..... —
Goolden (W. T.) and Co..... 11
Gülcher Electric Lt. & Power Co. 10
Holmes (J. H.) and Co..... 4
M. Immisch..... 21
Laurence, Paris and Scott (Ltd) 15, 17
NON-CONDUCTING COMPOSITION.
Bell's Asbestos Company 24, 25
OIL CLEANER. PAGE.
Woodhouse & Rawson United, Ltd. 7
PATENT AGENTS.
Berg (E.) ..... —
Chapman (J. C.) 28
PAINT, &c.
Indestructible Paint Co..... 28
PLATINA SCRAPS.
Jamieson (W. & J.) 2
PRINTING AND ENGRAVING.
Waterlow and Sons (Limited) .. 11
POROUS CELLS.
Joseph Bourne and Sons 17
Price, Sons and Co. ..... —
Stiff and Sons..... 8
PUBLICATIONS.
Telegraph Convention Codes .. 17
Woodhouse & Rawson United, Ltd. 7
PULLEYS.—Richards and Co. .. —
RESISTANCE COILS.
King, Mendham and Co. ..... —
Nalder Bros. and Co. 8
SALES BY AUCTION 3
SECOHMMETER.
Nalder Bros. and Co. 8
SECONDARY BATTERIES.
Drake and Gorham ..... —
Electrical Power Storage Co..... 20
SHEET IRON.
Baldwin (E. P. and W.) 17
SOCKETS.—General Electric Co.. 15
SUPPLIES FOR CABLE SHIPS.
Lack (F.) and Sons 28
Starnes (J. S.) and Sons 8
Duncan Wallet and Co. 28
SWITCHES.
Acme Electric Works 18
Crompton and Co. (Limited).... 14
Dorman and Smith 17
Drake and Gorham ..... —
Edison & Swan United Elec. Lt. Co. 5
Fowler, Lancaster and Co..... 3
General Electric Co. 15
Holmes (J. H.) and Co..... 4
Sharp and Kent 12
Thompson (N. G.)..... —
United Electrical Engineering Co. 156
Verity (B.) and Sons..... 21
Wolverhampton Electrical Co... 10
Wood (W.) and Co. ..... —
Woodhouse & Rawson United, Ltd. 7
TELEGRAPH ENGINEERS.
Acme Electric Works 18
Latimer Clark, Muirhead & Co.. 1
Elliott Bros. 19
W. T. Henley's Teleg. Works Co. 1
India Rubber & Gutta Percha Co. 14, 18
Johnson and Phillips 1
Telegraph Manufacturing Co. .. 2
TELEGRAPH PAPERS.
Waterlow and Sons (Limited) .. 11
TELEPHONES.
Blenheim (W.) and Co. ..... —
Fowler, Lancaster and Co..... 3
Gent and Co. ..... —
Stanhope Company 3
M. Theller and Sons 3
TOOLS.—Fenn and Co. 21
TRANSFORMERS.
Gülcher Elec. Light & Power Co. 10
Johnson and Phillips 1
Sharp and Kent 12
TUBES, &c.
Spencer (John) 8
TURNER.—Samuel Elliott 3
TYPE-WRITING.
Richardson (W. J.) and Co..... 18
VALVES.—Mosses and Mitchell .. 155
VENTILATING ENGINEERS.
Blackman Ventilating Company. 3
VOLTMETERS.
Acme Electric Works 18
Drake and Gorham ..... —
Edison & Swan United Electric Light Co. 5
Goolden (W. T.) and Co..... 11
Nalder Bros. and Co. 8
Sharp and Kent..... 12
VULCANISED FIBRE.
Mosses and Mitchell..... 155
VULCANITE.
Harburg India-Rubber Comb Co. —
Moseley (D.) and Sons ..... —
North British Rubber Co. 19
WIRE (Covered or Uncovered).
Latimer Clark, Muirhead & Co.. 1
Felten and Guilleaume 1
Fowler-Waring Cables Co., Ltd. 15, 19
W. T. Glover and Co. 17
W. T. Henley's Teleg. Works Co. 1
Johnson (R.) and Nephew ..... —
Johnson and Phillips 1
Laing, Wharton and Down 9, 17
London Electric Wire Co..... 17
Midland Electric Wire Co. .... —
Phillips Bros. 17
Phosphor Bronze Company 154
Pirelli and Co. 2
Telegraph Manufacturing Co. .. 2
Western Electric Co. 11
WIRE-COVERING MACHINES.
Barraclough and Co. 3
Johnson and Phillips 1
WIRE-TESTING APPARATUS.
Woodhouse & Rawson United, Ltd. 7
WOOD.—Garrard (Robert) and Co. —

Digitized by Google

E. P. & W. BALDWIN,

Works:—WILDEN, near STOURPORT.

MANUFACTURERS OF

PURE CHARCOAL SHEET IRON, SUITABLE FOR ELECTRICAL PURPOSES.

London Agents: BROOKER, DORE & CO., Corbet Court, LONDON, E.C.

NOW READY, THE

"TELEGRAPH CONVENTION" CODES,

IN

ENGLISH, LATIN, FRENCH, GERMAN, DUTCH, ITALIAN, SPANISH & PORTUGUESE

SECTIONS.

THE MOST COMPLETE TELEGRAPH CODE IN THE MARKET

All Further Particulars on Application to

"THE ELECTRICIAN" PRINTING AND PUBLISHING COMPANY, LIMITED,

1, SALISBURY COURT, FLEET STREET, LONDON, E.C.

ADDRESSES.

LAING, WHARTON, & DOWN, 82a, NEW BOND-STREET, LONDON, W., Electric Light Engineers & Contractors. Sole Operators for England of the Thomson-Houston system of Arc Lighting. Special Agents for the Edison-Swan Co.'s Incandescent Lamps and Apparatus. Manufacturers and Suppliers of every requisite for Arc or Incandescent Lighting, Dynamos, Lamps, Switches, Electroliers, Brackets, &c. Specialities in Primary Batteries for Electric Lighting, Venetian Shades and Glass, Carbons, &c. Temporary lighting on any scale at short notice. Estimates free. Telephone No. 3602.

JULIUS SAX, Electrical Engineer and Electric Light CONTRACTOR, RIDGMOUNT STREET, STORE STREET, LONDON, W.C.

Established 1855.

Specialities—Electric Bells, Burglar Alarms, Fire Alarms, Watchmen's Clocks and Fire Indicators combined, Water Gauges, Billiard Markers, Electric Vanes, Lightning Conductors, Speaking Tubes, Gas Lighters, Electrical Testing and Telegraph Instruments, Electrical Torpedo Apparatus.

Automatic Call Bells for Fire Stations, &c., fixed at all Stations under the control of the Metropolitan Board of Works.

Call Calls for Police Stations, Prisons, &c., as devised for and adopted by H.M. Home Office. Contractor to H.M. Post Office and War Office.

Electric Lighting—Domestic and Public. Estimates Free on Application. Eight Prize Medals awarded.

Telephone No. 3848. Telegraphic Address: "*Sax—London.*"

WALTER T. GLOVER & CO., Electric Wire and Cable Makers, SALFORD, MANCHESTER. Works: Bridgewater-street, Broughton-road, Salford; Salford Electric Wire Works, Salford; Springfield-lane Cable Works, Salford. Established 1868. London Address, 10, Hatton-garden, E.C.; Telegram, "Phonoscope," London; Telephone No. 6691. Manchester—Telegram, "Walter Glover," Salford; Telephone No. 1187.

Specialities—Glover's patent covered Gutta Percha Wire for Leading-in, Tunnel, and Underground Work. Specially covered Iron and Copper Wire for Aerial Lines. Fancy covered single and Double Copper Wire (Paraffined) for Telephonic and Bell purposes. All classes of Silk and Cotton covered Wires for Instruments and Dynamo Machines, Glover's Patent Electric Light Leads and Cables for the various systems.

All descriptions of Covered Wire and Cables for Telegraphic, Telephonic, and Electrical Work, as supplied to the Post Office and the principal Railways, Electric Light, and Telephone Companies.

ADDRESSES.

PHILLIPS BROS., Electrical Wire Manufacturers, The Lea Telegraph Works, HACKNEY WICK, LONDON, E., late of Macintosh-lane, Homerton. Established 1870. Telephone No. 5422.

Specialities—Gutta Percha, India Rubber, Compound, Cotton, Silk, Flexible Cords, Telephone Wire, &c., &c. Multiple and other Wires. Special Wires for Dynamo Machines. Electric Light Leads, &c Patent Non-Inflammable Insulation for Incandescent and Arc Lighting and Dynamo Machines.

THE LONDON ELECTRIC WIRE COMPANY, ANCHOR WORKS, PLAYHOUSE-YARD, GOLDEN-LANE, LONDON, E.C. (Late of Wenlock-buildings, Ironmonger-row, E.C.)

Specialities—Covered Wires of all descriptions for Electrical Instruments, Dynamo Machines, Bell and House Work, &c. Fancy Paraffined Wires specially prepared for Telephone and other indoor connections.

JOSEPH BOURNE and SON. Works: DENBY POTTERY, near DERBY. London: 6, ST. PANCRAS STATION. Manufacturers of the well-known Stoneware Telegraphic Insulators and Battery Jars. Brown Stoneware. White Stoneware. Brown Porcelain. Porous Cells. Economy, strength, durability, and perfect insulation combined. Prize Medal, Paris Electrical Exhibition.

Makers of Mr. Slater Lewis's Patent Self-Binding Insulator.

J. G. STATTER and CO., Limited, Engineers, ALLIANCE ENGINEERING WORKS, WEST DRAYTON. London Offices, Prince's Mansion, 68, Victoria-street, Westminster S.W. Dynamos and Motors for all Purposes. Perfect Constant-Current System of Arc Lighting. Estimates free. Write for Lists.

LAURENCE, PARIS and SCOTT, Limited, Electrical ENGINEERS and CONTRACTORS, GOTHIC WORKS. KING-STREET, NORWICH. Dynamos, Motors, Automatic Cut-Outs, Back Current Cut-Outs, Excess Alarms, Multiple Switches, and Switch Boards. Complete Electric Lighting Plants. Central Station Plants. Estimates on Application.

PATERSON and COOPER, Electric Light and Power and Telephone Engineers. EUROPEAN WORKS, POWNALL ROAD, DALSTON (Near Haggerston Station). Contractors to H.M. Government, Leeds Corporation, &c.

Specialities—Phœnix Dynamos, Pilsen, Phœnix, and Clark-Bowman and J. F. Arc Lamps, Cardew's Voltmeter, Paterson's Electromagnet Am- and Voltmeter, Ayrton-Perry Am- and Voltmeters, Wallace Diamond Carbons, Switches, Safety Junctions, and Fittings for Arc and Incandescent Lighting. (Removed from 76, Little Britain, since Nov. 16, 1885.)

Digitized by Google

THE

INDIA RUBBER, GUTTA PERCHA, & TELEGRAPH WORKS

COMPANY, LIMITED.

Offices: 106, CANNON STREET, LONDON, E.C.

MANUFACTURERS OF

DYNAMO MACHINES,

INSULATED ELECTRIC LIGHT WIRES AND CABLES,

Lamp Fittings, Switches and Testing Apparatus, Volt and Ampere Meters.

CONTRACTORS FOR THE SUPPLY AND FITTING UP OF

ELECTRIC LIGHT APPARATUS

OF EVERY DESCRIPTION.

INSTALLATIONS FOR CENTRAL STATIONS, SHIPS, HOUSES, OR FACTORIES.

ESTIMATES ON APPLICATION.

Works: SILVERTOWN, LONDON, E.

[See detailed advertisement facing "Notes."

BAR-LOCK TYPEWRITER
W. J. RICHARDSON & Co. 12 & 14 QUEEN VICTORIA St. LONDON. E.C.

THE ONLY MACHINE
ON WHICH
THE WRITING IS VISIBLE,
AND EVERY LETTER
Printed on a Straight Line.

Will Manifold SIX Good Copies of a Specification at One Time.

TIME IS MONEY; TO SAVE TIME IS TO GAIN MONEY. The **BAR-LOCK TYPEWRITER** will *SAVE ITS COST EVERY TWO MONTHS*, for with it you can do your writing in One-Third the Time it now occupies with a pen, with Less Fatigue, and in Much Better Style. The Machine is so simple that the Speed of a Pen can be acquired in SIX HOURS.

SPECIMENS OF WRITING AND FULL PARTICULARS POST FREE.

W. J. RICHARDSON & CO.

12 & 14, QUEEN VICTORIA STREET, LONDON, E.C.

F. W. BERK & Co.

MANUFACTURERS OF

SULPHURIC ACID. NITRIC ACID. MURIATIC ACID.

ALL STRENGTHS PREPARED ACCORDING TO REQUIREMENTS.

WORKS: ABBEY MILLS CHEMICAL WORKS, STRATFORD. E.
PENTREPOTH CHEMICAL WORKS, MORRISTON, NEAR SWANSEA.
OFFICES: 1, FENCHURCH AVENUE, LONDON. E.C.

THE

ACME ELECTRIC WORKS

(ARTHUR C. COCKBURN, M.I.E.E., Manager),

FERDINAND STREET, CHALK FARM ROAD, N.W.

SWITCHES ON SLATE OR CHINA,
CUT-OUTS (COCKBURN'S PATENT,)
DISTRIBUTING BOARDS,
GLASSWARE.

AYRTON AND PERRY'S AMMETERS AND VOLTMETERS IN STOCK.
SOLE LONDON AGENTS FOR ROYCE'S DYNAMO.

ELECTRICAL CONTRACTORS
ARE INVITED TO CALL, AND INSPECT OUR STOCK AND SAMPLE ROOMS, AND OUR FACILITIES FOR TURNING OUT WORK WELL AND CHEAPLY.

TRADE "SANITAS" MARK.

DISINFECTANTS

(FLUIDS, POWDER, SOAPS),

NON-POISONOUS, PLEASANT AND BEST.

Used by more than 1,000 Boards of Health and Hospitals.

Gold Medals, Calcutta 1883-84, Paris 1885, Antwerp 1886.

For use at the Home and Foreign Stations of Telegraph Companies and on Board Ship

"Valuable Antiseptic and Disinfectant."—*Times*
"Safe, pleasant, and useful."—*Lancet.*

The "Sanitas" Company, Limited,
LETCHFORD'S BUILDINGS, BETHNAL GREEN, LONDON.

Digitized by Google

very definite ideas. It is not by any means an unworthy task to endeavour to shape with the utmost care the definitions and nomenclature of a science. Even in the case of the older sciences, like dynamics, great good results from a careful re-examination from time to time of the phrases and definitions and terms employed. A loose or inappropriate vocabulary is a great bar to the progress of discovery, and an inestimable boon is conferred on scientific workers by anyone who readjusts the vocabulary of a science so as to be more in accord with the facts. The great service rendered to electrical science by Dr. G. S. Ohm is known to every student. We have only to refer to the writings of the early investigators of galvanism and electro-magnetism to see how much they were fettered by the want of precision in nomenclature. To analyse any complex phenomenon like the production of an electric current into its simple constituent notions, and to affix to each idea or fact an appropriate name, is a work of time; and even when those who have thought most deeply on the subject have decided amongst themselves what will be the proper mode of naming and analysing these facts, it involves still greater delay before the general body of workers have been brought by education or training to view the phenomenon from the same point of view. The older chemists, brought up to regard the phenomenon of combustion from the point of view of the phlogiston theory, had considerable difficulty in assimilating the ideas and terms which LAVOISIER'S discovery of oxygen and his theory of combustion involved. It thus happens that different sections of scientific workers speak and think in terms or phrases which are dissimilar. The purely scientific worker adopts terms or phrases which have been suggested to his mind by experimental or mathematical analyses, having as their only object the disentanglement of the true from the false. The more practical or constructive worker, one whose work consists in applying known principles and facts in everyday life, requires a vocabulary which is more picturesque or suggestive than that adopted by the scientific worker. Electric pressure, as a term, is to the practical man more suggestive than electric potential; number of lines of magnetic force than magnetic induction, or surface integral of magnetic force, and magnetic resistance than magnetic permeability. The practical constructor and the scientific investigator have thus some difficulty in adapting their thoughts to one common language. The practical man is apt to take too simple a view of Nature. He dislikes complex ideas; and, provided a phrase is good enough for him, he does not see why his scientific brother should be always wanting to coin fresh words or new phrases. The investigator of first principles knows, however, that there can be no finality in our ideas of any phenomena of Nature. All conceptions of natural facts and effects, and of the interpretation to be put on them, are imperfect. At every stage of knowledge our views of the connection of phenomena are imperfect, and the language in which ideas about them are expressed requires continually to be re-modified.

In an enormously progressive science like electricity there is the greatest difficulty in bringing the vocabulary of the science into accordance with the most highly probable interpretation of the facts, and hence arises a continual need for readjustment and modifications. Meanwhile, the facts remain the same, and those whose contact with the science consists rather in applying the facts than in examining their connection and relation to other facts, are apt to be satisfied with modes of expressions which are very imperfect in themselves. A mode of viewing certain phenomena which seems consistently to explain, up to a certain point, the facts, may be rendered very misleading by the discovery of further facts. For instance, the phenomena of self-induction carry with them and suggest certain ideas in electrical science which are the analogues of those which arise in connection with the idea of inertia in mechanical science. Electric inertia becomes a phrase which is taken into use to express definite ideas. Additional light on the true mode of viewing the genesis of electric currents in conductors may reveal that the whole phenomenon is much more akin to the gradual propagation of heat through a poker which has one end stuck in the fire, and that to connect the idea of inertia and mechanical momentum too absolutely with the gradual rise or decay of electric currents may be to avert the mind from that which it is necessary to study to advance our knowledge of the whole matter. If, however, a practical man has once found that expressions or terms based on that mode of regarding electric phenomena which renders their connections clearer by the use of language based on an analogy with the motions of a heavy fluids—then, finding that up to this point he is helped by it, he is apt to cling to it with considerable tenacity. Hence there is a difficulty in reducing to one common language the ideas of those who have different levels of thought and practice. To a practical telegraphic engineer the propagation of an electric signal or current through a wire is a much simpler matter than it is to a mathematical physicist, and the words they use to express themselves about it are therefore different. The practical man is apt to regard a good deal of the scientist's verbiage as a "vain thing fondly invented," and as having no reality. The theorist knows that the very essence of further practical applications is a continual advance in exploring the inmost nature of elementary phenomena.

From time to time practical science enters new fields of enterprise, and encounters in so doing facts and effects of a novel nature. So it has been particularly in the employment of periodic electric currents in telephony and electric lighting. It is then that a necessity arises generally for re-casting the vocabulary with the object of obtaining more precision and directness of expression in dealing with the effects and quantities which have to be measured. We have a particular instance of this in the terms which have been lately defined by the authority of the British Association Electrical Standards Committee. The term *impedance* has been adopted in the case of periodic currents to express the ratio of the square root of the mean square of the electromotive force during the period to the corresponding function of the current strength. And these quantities are respectively to be called the *effective electromotive force* and the *effective current-strength*. They are practically the quantities which are measured by a hot-wire voltmeter and an electro-dynamometer. The term effective electromotive force has been employed by some writers, when dealing with periodic currents, to express the difference between the actual external electromotive force acting in the circuit and the counter-electromotive force due to induction. In this last use of the term, the actual current flowing is numerically determined by the quotient of the so-called effective electromotive force by the real resistance of the circuit.

This selection of terms is, as some of our correspondents have pointed out, by no means entirely free from objection. This only shows how difficult it is to construct the vocabulary of any of the more recent developments of scientific work in a way that will render it at once complete and uniformly acceptable. There is much to be said for or against any of the terms which have thus been authoritatively defined. Time alone will show how far this nomenclature will find general acceptance, but meanwhile the advantages of a uniform mode of expression amongst writers and speakers is so great as to make it worth while to secure this, even if the terms and phrases are not destined to be absolutely permanent.

Digitized by Google

THE INSTITUTION OF ELECTRICAL ENGINEERS.

The annual general meeting of the Institution of Electrical Engineers was held last night at the Institute of Civil Engineers, Great George-street, Westminster, when the undermentioned officers and Council for the ensuing year were elected :—

Officers and Council for 1890.

President.

J. Hopkinson, M.A., D.Sc., F.R.S.

Vice-Presidents.

William Crookes, F.R.S. | Alexander Siemens.
Prof. W. E. Ayrton, F.R.S. | R. E. Crompton, M.Inst.C.E.

Members of Council remaining in Office.

Major Philip Cardew, R.E. | Gisbert Kapp, Assoc.M.Inst.C.E.
W. Lant Carpenter, B.A., B.Sc. | Prof. John Perry, M.E., D.Sc., F.R.S.
Sir James Douglass, F.R.S. | Sir David Salomons, Bart., M.A.
Sir Douglas Galton, K.C.B., D.C.L., LL.D., F.R.S. | Prof. Silvanus D. Thompson, B.A., D.Sc., F.R.A.S.

New Members of Council.

Sir James Anderson. | Sir Henry C. Mance, C.I.E., M.Inst.C.E.
Sir Albert J. Leppoc Cappel, K.C.I.E. | Colonel R. Raynsford Jackson.

Associate Members of Council.

Augustus Eden. | Francis H. Nalder.
Sidney Sharp.

Hon. Treasurer.

Edward Graves.

Hon. Auditors.

Frederick C. Danvers, India Office, S.W. ; Augustus Stroh.

Hon. Solicitors.

Messrs. Wilson, Bristows, and Carpmael, 2, Copthall Buildings, E.C.

Bankers.

Messrs. Cocks, Biddulph, and Co., 43, Charing Cross, S.W.

Secretary and Editor of the Journal.

F. H. Webb.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

"Electrical Engineering in America."*

BY G. L. ADDENBROOKE, ASSOCIATE.

(Continued from page 122.)

Underground Work.

Turning now from this branch of the subject to underground work, I must confess that I had a good deal of difficulty in getting really accurate and reliable information on this subject—at any rate, of a comparative character. The Edison Company have, of course, buried their wires all along, and their three conductors enclosed in an iron tube, run solid, with insulating material inside, are well known. As far as I could ascertain, the various systems of conduits have not proved very successful so far, and, since the proof of the pudding is in the eating, the fact that the Subway Company in New York are, I believe, laying down iron pipes entirely—at least, they were in every place I saw work going on—points to this conclusion.

The system of construction for underground work at present being carried out in New York is as follows :—Manholes at convenient distances are made in the roadway—not, as a rule, in the pavement, but just on the rise of the road, and clear of the gutter. These manholes are circular, and are covered by a heavy iron lid. Below the manhole is a bell-shaped pit eight or nine feet deep, and bricked round, and of sufficient size at the bottom for a couple of men to stand fairly comfortably to work. Iron pipes, such as are used for water or gas, are laid in the ground from one manhole to the next. I understand that each electric company will, as a rule, have a separate pipe, so that if there are several companies running along the street, they will each require a separate line of piping opening into the manhole. There will, therefore, often be several pipes entering at each side of the manhole. These pipes enter the manhole at such a height as, roughly, to come between the hips and breast of a man standing on the bottom—at a height, in fact, to bring them in a fairly convenient position for working. The cables are drawn through the iron pipes in the ordinary way. Branches are taken from the manholes under the roadway and pavement to any house between the manholes requiring current. As regards the class of cable which is being largely laid down in these conduits, the conductor consists of seven strands of No. 16 copper. These are insulated by a layer of a hard but somewhat flexible material, containing, I believe, some rubber in conjunction with other materials, but the complete material is cheaper than rubber used alone. The thickness of this material surrounding the conductors is one-twelfth of an inch. It somewhat resembles ebonite, and is of a consistency to stand rough usage and hard wear. It will be interesting to see how it lasts in practice. I must say it seems to me a very suitable material for the purpose for which it is intended ; and, as far as insulating qualities go, I was able to see the record of tests of a good deal that has been laid, and they were excellent, going up to several thousands of megohms per mile. The insulating material is covered with a lead pipe about one-sixteenth of an inch thick, and containing, I believe, a percentage of tin. These lead-covered cables are usually jointed at each manhole, and a little slack left on them there. The jointing is done by a special system, and when it is complete electrically the two lead tubes are drawn together over a small bit of brass tube, which protects the point of junction ; they are then "wiped" together with a hot iron like an ordinary plumber's joint. No doubt this work is heavy and expensive, but it looks as if it should last when once put down.

Internal Work.

Coming now for a moment to the internal work in buildings, most of what I saw had a rough, temporary look about it, evidently being put up as cheaply as possible. I do not say that no good, solid work is done, but the proportion of it to the remainder is, I fancy, a good deal smaller than in this country. Gas-fittings are freely utilised, and I think I am correct in stating that in the arrangement of lights the gas-fitting way of managing things is adhered to much more closely than in this country, where we have rather tried to avoid imitating the ordinary ways of arranging gas lights.

Turning aside for a moment, it appears to me that one of the great wants all over the world now is, if I may so term it, a "science of illumination." Up to and as far as *providing* light we are exceedingly scientific. But in *utilising* it when we have got it, we proceed in an elementary and haphazard manner. Mr. Preece has, I know, from the first paid a great deal of attention to this point, and appreciated its value. It seems to me that it would really be of great practical benefit if a Committee of this Institution, or some other responsible body, would accumulate some accurate and authoritative data on the subject. When once started properly, these data would increase of themselves, and would soon form a guide which would be exceedingly useful in drawing up specifications and arranging to the best advantage the lighting of either open spaces, public buildings, or private houses. We all have our own indefinite notions on the subject as the result of experience, but if they could only be put into definite shape—and I think the subject does admit of being put into definite shape—it would, I feel sure, be a great advantage.

Of course there are innumerable patterns of switches and cut-outs and fittings in America, as here, but none came to my notice showing any very brilliant conception in design. Lamp sockets and fittings are generally somewhat larger and clumsier than with us. The chief difference I noticed was that a switch is almost invariably included in each lamp socket. Americans, as a rule, do not go to the same amount of trouble and expense that is general here to fix switches in handy places near doors. If you want the light on or off, you turn it on or off at the burner as you would do gas.

Central Stations.

Coming now to central stations, those I went over were the new Arc Light Station in San Francisco, the Edison Station in Chicago, the Westinghouse Station in Pittsburg, and the Thomson-Houston Station in New York ; and I may add that since my return to London I have had an opportunity of going carefully over the new Westinghouse Station in Sardinia-street, Lincoln's Inn Fields, the plant in which is entirely of American manufacture and pattern, and arranged in the American manner. I might easily have seen many more stations—in some cases, perhaps, larger and better arranged than those I did see. But those I did see are, I think, all typical of the latest American work, and all were in the process of making large additions to their plant, so that they were quite up to date.

The station in San Francisco is near the railway station. It is a large brick building, erected entirely for its present purpose, about 250ft. long by 80ft. broad, with a ground and two upper floors, and has been finished about eight months. It is intended to provide accommodation for about 2,000 arc lights when filled up. At present it is furnishing current for about 600. It is arranged in the usual—I was going to say invariable—American plan of placing the engines and boilers on the ground floor, and arranging the dynamos, switch-boards, and electrical portion of the station on the first floor. In this instance the second floor is used as a storehouse, and for

* Paper read before the Institution of Electrical Engineers, November 28, 1889.

Digitized by Google

general purposes. The boiler-house forms one end of the building, and there was nothing above it. It is arranged for two lines of boilers, one on each side, one side only being filled up at present. They face towards the centre of the building, with a large space between for coals and general working purposes. The boilers were of the well-known water-tube pattern. This type, varied slightly in detail by each maker, seems to be in general use everywhere in the States. From the boilers the steam is led to a 650 horse-power single cylinder Corliss engine, which, by rope gearing, drives a single line of countershafting. I must say I was surprised to find that, in a new station so large as this, and one in which expense evidently had not been spared, the engine was neither compound nor condensing, particularly as there was water within a moderate distance. There was only this one engine in the station, driving all the dynamos, though space was provided for three more as the amount of lighting increased. The working of the station was therefore dependent on the single engine and line of shafting keeping in good order. The engine drove this line of countershafting, as I have said, the loose pulleys being on the shafting. At the stations I visited, where countershafting was in use, I was struck with the care and completeness with which means were provided for adjusting the plummer blocks and bearings in any direction. The general idea was somewhat as follows:—The plummer block, or upright, stood in a cast-iron shoe with a flat planed bottom, through which the holding-down bolts projected. The holes for the holding-down bolts in the plummer block were bored large so as to permit a certain movement in the block. The edges of the cast-iron shoe were turned up all round, and through these edges projected screw-bolts, the points of which touched the plummer block. By loosening, then, the holding-down bolts at any time, and screwing or unscrewing the screw bolts as required, the block could be slewed slightly or adjusted to line with the greatest nicety and ease. Besides this, the under bearing worked in guides, being kept in its place by a strong screw projecting up from underneath. By working on this screw, and on the cap of the upper bearing, the height of the bearing could, of course, be adjusted with great exactness. With these means the brasses are also quickly and easily replaced; while, if they get warm when the shaft is running, the bottom bearing can be slacked down. The Thomson-Houston Company, in New York, told me they did this, and their dynamos are on the same floor as the line of shafting. It is, of course, a still simpler and safer matter to do this when the dynamos are situated almost right above the shafting, as is the general practice in American stations. Leather belting of the ordinary description was in use, except for driving, where ropes are used, as I have mentioned. I found leather belting employed at each of the stations I visited. These long lines of countershafting must, of course, be wasteful of power; still, it is worth pointing out that such shafting runs under the best conditions when doing work right overhead, since both the dead strain and the running strain on the belts to the dynamos tend to lift the line of countershafting, which, therefore, if the weight is properly adjusted, must run very lightly in its bearings. The method of driving from underneath is also economical in belting, since the weight of the belt hanging on the dynamo-pulley causes it to have a good grip, and permits of a short length being used. The belts pass up to the dynamos through holes in the floor, the holes being elongated to permit the belt being tightened, if necessary, by screwing the dynamo along on its bed rails. In each of the stations I visited in America the upper floor carrying the dynamos was entirely of wood, strongly made, and supported from underneath at intervals by stout wooden uprights, but still of wood. The weight of the floor in the San Francisco station is entirely supported by the wooden uprights, being only steadied at the sides. I was informed at the old station in San Francisco, worked by same Company, and which, I understood, was supplying about 1,200 arc lights, a good deal of trouble was experienced from the floor, which was fixed to the walls, and which, vibrating with the motion of the machinery, shook the brickwork. I found the vibration on these wooden floors less than I anticipated, considering the amount of machinery on them; but, of course, the motion of a good dynamo is very even, and if the joints on the belt are neatly made there is no jerking. In this San Francisco station all the machines were Brush 60-lighters. From 50 to 60 lights in series on one circuit seems to be about the general rule for lighting in America when any number of lights is required. As all the machines are run from the same countershafting, and at the same speed, whatever work they may be doing, it is necessary to provide an automatic regulator to adjust the current through the field-magnets for each machine when doing less than its normal output. On the other hand, if the circuit is a very long one—and I was told some of the circuits at San Francisco are as much as 13 or 14 miles—the number of lamps on the circuit must be reduced to compensate for the extra resistance. These Brush dynamos were all mounted on short iron columns about 9 inches high, so that they were lifted entirely from the floor. I was told that this arrangement was found very handy for keeping the machines clear and free from dirt, and for inspecting them. I did not notice much difference between the machines and those turned out by our friends on this side of the water, and the style of the workmanship seemed to be about the same. A light overhead trolley, with lifting gear, ran overhead so that it could quickly be brought over any machine, and I was informed that should a machine go wrong, they could replace an armature in half-an-hour. In the older station in San Francisco a large number of Thomson-Houston machines are used, but Brush machines only are employed in the new station, as they find the Brush armature is more easily replaced, and is so much the easier of the two to repair if anything goes wrong. It is worthy of note in this connection that the latest advices from America inform us that the Thomson-Houston Company have bought the Brush Works at Cleveland, Ohio, and therefore presumably the Thomson-Houston Company will in the future control this interest as well as their own. From the dynamos the mains are led to a long narrow shelf, where are fixed the resistances and indicating instruments for each machine. The mains next proceed to the switch-board, which is of the plug pattern—brass plugs with boxwood handles united by a flexible insulated cord. All the flooring being of wood, as it is in each of the stations I saw, and being kept clean and dry, the risk of getting a bad shock is not great, except by shunting the current through oneself, or getting in series with a main, which are not ordinary accidents. At San Francisco the motor business is steadily increasing, and forms a welcome addition to the revenue of the station, without a very great additional expenditure.

I will now go on to the Edison Station in Chicago. There is no necessity to describe it at length, as the plans on which Edison stations are constructed have been published over and over again. The boilers, which are situated on the ground floor, are of the water-tube pattern—Heine arrangement. In this pattern, which seems to be a good deal used, the tubes are much more nearly horizontal than in the well-known Babcock and Wilcox type. All the tubes come into a large flat box at each end, and there are small manholes in the boxes opposite the ends of the tubes, for getting at them. These flat boxes are prevented from expanding with the pressure by tubular stays, which pass right through them, and are expanded in their places. These small tubes serve as blow-holes for directing a jet of steam on the upper side of the tubes to clear them of ashes. They are kept plugged up with a stopper, under ordinary circumstances, to prevent the gases coming through. These boilers had a damper projecting downwards in the furnace opening, for directing the draught over the surface of the coals when firing, to cause more complete combustion and prevent smoke. This damper may have been of some use for the purpose, but it certainly made it a difficult operation to fire properly. The engines were also in the basement, in the next room to the boilers. They were of the ordinary Armington-Sims pattern, single cylinder, and neither compound nor condensing. There was one to each dynamo, the dynamos being situated overhead on the floor above. The dynamos were of the ordinary Edison pattern, for, I think, 1,500 lights each. Everything was very neatly arranged in the dynamo room, the current being conveyed about by large copper bars. The walls were simply lined with resistances and indicators for the different circuits. In fact, the place gave one rather the impression of a wholesale clock store, though the attendant informed me they did not have much difficulty in keeping their resistances properly adjusted. All the mains are underground, on the three-wire system. Indeed, there is a good deal of underground work in Chicago, the Telephone Company also having a large number of cables buried.

(To be continued.)

THE PHYSICAL SOCIETY.

At the meeting of this Society, held on the 5th inst., Mr. S. Bidwell read a Paper on

"The Electrification of a Steam-Jet,"

illustrated by some beautiful and striking experiments. The jet was obtained from a small boiler, formed out of a tin canister, into the neck of which a cork was fitted, and this cork was traversed by a tube bent at right angles, and terminating in a nozzle. The object of bending the tube in this manner is to avoid having the flame used for boiling the water in the boiler immediately under the steam-jet, as the effect would then be to dissipate its charge of electricity. It is desirable that the glass tube should be as free from water as possible, and therefore it should be of comparatively large diameter. The tube employed in the experiments shown to the Society was $\frac{5}{16}$ths of an inch in diameter, and the nozzle at its extremity $\frac{1}{16}$th of an inch in diameter. Some four ounces of water were introduced into the small boiler, and heated until a strong but steady steam-jet was seen to issue from the nozzle (if the ebullition is too violent the water thrown up into the tube will produce unsteadiness); the image of the steam-jet was then thrown upon a screen by means of a projecting lantern,

Digitized by Google

and was seen to be of feeble intensity and of a neutral colour, being in fact nearly transparent, and appearing to exert little or no selective absorption upon the beam of light transmitted through it. A small bundle of needles in connection with one of the terminals of an influence machine was then brought near to the base of the jet, and the machine was slowly worked. The image of the jet instantly became dark and dense, and assumed a marked orange-brown tint, but instantly returned to its original condition when the electrified points were removed or earth-connected. It is not necessary for the points to be directed to the origin of the jet, as they are nearly as effective when placed in the steam at a distance of a foot from the nozzle, the whole of the steam-jet, from the nozzle upwards, being acted upon just as before. If a ball is used instead of a point, a similar result is obtained when the ball is actually within the jet, but not otherwise. Similar results may be obtained by directing the jet upon an electrified metal disc, which may be at a considerable distance from the nozzle. The author stated that he had examined the absorption spectrum of the steam-jet, and had found that, when unelectrified, the jet had very little action upon the spectrum, its total effect being merely to slightly diminish the brightness of the latter, the diminution appearing to be of equal intensity throughout, though he thought it possible that the violet might be dimmed slightly more than the other colours. Electrification was found to cause a total disappearance of the violet, and, at the same time, the luminosity of the blue, and the more refrangible part of the green, was decidedly diminished. The orange and red did not appear to be affected.

The author concludes from these observations that the effect of electrification is to cause an increase in the size of the water particles contained in the steam-jet. When the jet is unelectrified, most of these particles are small compared with the wave-length of light, but when electrified, their diameter may be something like $\frac{1}{5000}$th of an inch. It seems natural to suppose that the phenomenon was analogous to an experimental result obtained by Lord Rayleigh, in which a stream of water issuing almost vertically from a small orifice was found to break up into small drops at a certain distance above the orifice: and while, under ordinary circumstances, these drops collide with one another and become scattered over a considerable space; when an electrified body, such as a rubbed stick of sealing-wax, is brought near the point at which discontinuity begins, the drops no longer rebound, but coalesce, and the entire stream of water, both ascending and descending, appears to become adherent. The author observes that in the case of the steam-jet the minute particles of water, each consisting of minute molecules, must necessarily collide frequently with each other, and therefore it would seem that they ought to behave in the same manner as the larger drops of the water-jet, rebounding when unelectrified, and coalescing into larger drops when electrified. The fact that a much higher degree of electrification is required to produce the effect in the case of the steam-jet, rubbed sealing-wax being quite inoperative, scarcely seems to agree with this explanation; but the author suggests that the difference may possibly be due to the different sizes of the drops in the two cases, and in support of this he adduces the fact that if two electrified steam clouds are generated in close proximity to each other, they exhibit little, if any, mutual action; so that the electrification of the water particles must really be extremely small. Lord Rayleigh shows cause for believing that if the drops in the water-jet were all equally charged the phenomenon would not occur; and to whatever cause this inequality may be due, it would probably be equally effective in the case of the steam-jet. Lord Rayleigh has not suggested any explanation of the manner in which unequal charges of electricity of the same sign could bring about coalescence, and the author has not any suggestion of his own to make on the matter. Lord Rayleigh, in a Paper describing this phenomenon, points out its importance in connection with meteorological phenomena, and the author suggests that his own experiments with the steam-jet appear to suggest an explanation of the intense darkness characteristic of thunder-clouds, and also of the lurid yellow light by which their darkness is often tempered.

In concluding the account of his own experiments, the author stated that subsequent to their completion, and to his having offered the paper to the Physical Society, Professor S. P. Thompson had called his attention to a Paper by the late R. von Helmholtz (Wiedemann's *Annalen*, Vol. XXXII., p. 1), describing experiments made by him upon the electrification of a steam-jet. Helmholtz did not appear to have examined his jets by transmitted light, and made no mention of the great increase of opacity under electrification. In his experiments the jet was invariably observed against a dark background, illuminated by a ray of light coming obliquely from the front and shaded from the eyes. He found that when the jet was electrified, it was seen much more clearly and sharply defined against the background; and diffraction colours, similar to those seen in fog-strata, were exhibited. When the jet was very strongly electrified, a deep blue colour was produced, showing that very small mist drops were formed. When the electrification was slowly diminished, the blue tint became gradually paler, indicating the formation of larger drops, and this was succeeded by tints of purple, red, yellow, green, and ultimately, when the discharge became very feeble, pale blue again. Under certain circumstances all these different tints could be observed simultaneously in different portions of the jet.

The author stated that he had observed these diffraction colours in his own experiments, but he did not follow up the observations, as he found that they occurred when no electrical influence known to him was operating.

Helmholtz found that these condensation phenomena could be produced equally well by causes other than electricity, more particularly by the aid of flame. All the causes in question involved some continuous chemical action within the steam-jet, and he therefore thought the sudden condensation might be ascribed to molecular shocks upsetting the equilibrium of the supersaturated vapour, in very much the same way that a supersaturated saline solution can be made to crystallise by a slight disturbance. The author then illustrated the effect of combustion by holding a piece of burning touch-paper, made by soaking blotting-paper in a solution of nitrate of lead, underneath the jet, it being impossible to employ a flame, as it would discharge the electrification of the jet. It was immediately electrified in exactly the same manner as by electrification. The burning touch-paper appeared more convenient than the flame employed by Helmholtz, as it would be impossible to place the latter under the jet without dissipating it, and it would, therefore, be necessary to hold it on one side and blow the heated gases on to the jet.

The experiments described in Helmholtz's Paper naturally suggested to the author to try the effect of combustion on the water-jet, in which case, of course, the objection to the use of a flame did not apply. A Bunsen flame was therefore introduced into the jet, and it was found that when the air-holes of the Bunsen burner were stopped up, so as to make the flame luminous, the effect was generally similar to that of electricity, but was not obtained with the same perfect certainty; but when the burner was held a little below the point of resolution a great diminution of the scattering was invariably observed. The non-luminous flame had no effect whatever upon the jet. The author suggested that the effect of the luminous flame might possibly be due to its being electrified, as it is well known that luminous flames are electrified, in illustration of which he placed a luminous gas flame between the points of a Voss influence machine in action, the terminals being so far apart as to prevent sparks from passing, and it was observed that the upper part of the flame was repelled by the positive and attracted by the negative knob. The author mentioned, in concluding his Paper, that Helmholtz had suggested, as an alternative hypothesis to that of molecular shocks, that the electrical discharge of the flame or other exciting agent might possibly act by introducing small particles of solid matter into the steam-jet, which particles might act as nuclei upon which the water vapour might condense, as in Aitken's experiments upon the formation of fog.

DISCUSSION.

In the discussion which followed the reading of the Paper,

Prof. RÜCKER inquired whether the author had considered the effect of surface-tension upon the flame; for, as he pointed out, the higher the surface-tension the more rapidly would rupture take place. The surface-tension would be altered by the action of heat, and perhaps also by the introduction of solid particles, and both these would act in the same way.

Mr. RICHARDSON inquired whether the author had tried the effect of substituting red-hot iron instead of a flame, as in that case no solid particles could be introduced.

Prof. HERSCHEL remarked that the silky clouds often observed hanging over volcanoes after an eruption, might possibly consist of vapours of sulphurous acid and other substances condensed electrically in this manner.

Dr. FISON stated that in some experiments which he had made with a wire, held at various distances above a Bunsen flame, the greatest amount to which the potential of the wire was raised above that of the earth was about 2 volts, gradually diminishing as its distance above the flame was increased, until the electrification changed sign and increased negatively to a potential of 1·5 volts. It seemed to him that these charges would be too small to produce the observed effects.

Prof. S. P. THOMPSON observed that there seemed, according to the author's experiments, to be a curious contrast between steam jets and other clouds. For example, in Dr. Lodge's experiments it was found that fog could be dissipated by electrification. He inquired whether the author had observed the existence of any relation between the amount of change in the colour of the jet and the length of the spark.

Mr. BIDWELL, in replying, said since writing the Paper it had occurred to him that the effect of the flame might possibly be due more to the presence of dirt than to electrification, and, in illustration of this, he pointed out that Lord Rayleigh had found that the experiment did not succeed when the steam was obtained from soapy water. He had not tried the effect of using hot iron in place of flame, but he did not think it would produce any effect. Dr. Fison's observation of the greatest difference of potential obtainable from a flame was in agreement with what had been noticed by other observers, but he did not think the charge was necessarily too small to account for the effects observed when the flame was placed

Digitized by Google

between the terminals of an influence machine, for it must be remembered that though the flame might only be charged to the extent of a couple of volts or so, the difference of potential between the terminals of the machine would amount to some thousands of volts. He had not obtained any definite relation between the colour of the jet and the sparking distance; indeed, the colour appeared to be unchanged, whatever the length of the sparks, except on one occasion, when he thought he observed a slight tinge of slate colour when the sparks were very long, and the machine was turned very rapidly; but he was not able to obtain the result again upon repeating the experiment.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *November* 30, 1889.

The Overhead-Wire Agitation.—The overhead-wire question in this city has now come before the attention of the Grand Jury. When the Grand Jury first took the matter in hand, it was supposed that they intended to bring in some indictment against one or other of the Arc Light Companies to whose defective circuits the death of the lineman Feeks could be traced. But the Grand Jury do not appear to have found themselves in possession of such evidence as would warrant them in ordering an indictment, and it is now understood that they will restrict themselves to recommending various improvements in the matter of line construction, and in the character of the insulated wire used. It is possible also that this body may have some recommendations to make with regard to the subways, but it would be very hard to convince any intelligent and reasonable body of men that the subway system here is such as it ought to be. At the present time several of the leading thoroughfares have been ripped up again for the extension of the subway system, and the roads are consequently in a woeful state of mud and impassibility. It would be hard to say how often some of our leading streets have been turned up during the present year, but it is evident that the people have already reached the extreme of patience and endurance in this respect, and I should not be surprised to see legislation against any further tearing up of the pavements. As I close this letter, the Grand Jury have made a powerful presentation against the Board of Electrical Control, practically recommending its abolition.

Farewell Banquets to Mr. J. D. Reid.—Among the interesting events of the week have been the farewell banquets in this city to Mr. James D. Reid, of the Western Union Telegraph Company, who has been appointed United States Consul at Dunfermline, his native place. The first of these banquets was given to Mr. Reid by the Magnetic and Telegraph Clubs of this city, and on that occasion Mr. Reid was presented with a handsome gold medal suitably inscribed. In his response he gave some very interesting details as to his work in connection with the telegraph in its earliest years. He was the first man in the world to learn the Morse telegraph without an instrument; he opened the first telegraph office for commercial purposes in this country; he was the first man to introduce iron wire into the telegraph service of America; he was the first man to devise means for protecting the circuits from lightning, and was rewarded with a silver medal by the Franklin Institute; he was the first Superintendent of Telegraphs ever appointed, and he sent the first President's Message that ever passed over the telegraph wire. These were but a few of his interesting exploits in his early days, a fuller record of which, as well as of the whole development of the telegraph service, may be found in his own interesting "History of the Telegraph in America." Mr. Reid was also a close friend of Prof. Morse. The interest that attaches to Mr. Reid's career, however, is not merely that of a pioneer, for what has mainly distinguished him during his long telegraphic career has been his kindliness and gentleness, the most forcible expression of which may be found in the Telegraphers' Mutual Benefit Association, which he established, and which, in the course of a few years, has been the means of an immense amount of good in securing insurance benefits to the widows and orphans of telegraph officials and operators. The second dinner to Mr. Reid was given him by the Western Union officials and by a number of his personal friends.

A New System of Interior Wiring.—Attention has been called in the electrical papers this week to the system and methods of the Interior Electrical Conduit Company, which has been busily engaged in elaborating a system of interior wiring for incandescent work. Here, hitherto, the methods employed in interior wiring have been such as probably you are familiar with in England, *i.e.*, the wires have been carried along the walls and ceilings externally, and covered by mouldings, or have been buried in the plaster out of sight. Work on either of these methods can, of course, be well done; but it is only too often done badly. The mouldings are clumsy and badly put up, disfiguring the paper, or other coverings, and if the wires have been buried in the plaster, there have been numerous grounds, leading to chipping and breaking away of the walls and to great annoyance and expense. In the system elaborated by the Company named the wires are all carried through the building in conduits made of papier-mache, subjected to treatment with some bituminous asphalte compound, which renders them non-conducting and impervious to moisture. The tube is made in lengths of about ten feet, in sizes ranging from $\frac{1}{4}$in. to $1\frac{1}{4}$in. inside diameter, and these lengths are joined together by sleeve couplings, and can be right-angled or be fitted with elbows for rounding curves and corners. These tubes terminate in junction boxes and switch-closets, and hence the building can be tubed throughout before an inch of wire is put into it. Then the wire can be easily drawn in, in accordance with the wants of each floor, and the whole system can be quickly put into operation. One of the ideas in connection with the system is the use of twin conductors. Another detail of this system is that the wiring is done on what is called the distribution method—that is to say, instead of running the main conductors clear through the building from the dynamo to the top floor, and taking off a feeder on each floor, distribution points are located midway in the installation, and from those the sub-circuits are run; so that down to the last lamp a system of equalised pressure and perfect balance is maintained, with the further result that all the controlling devices are located in familiar places and are easily found. There seems little reason to doubt that the system as worked out is a marked advance in the art of interior wiring, and that it is likely to come into very general use. One of its great features of advantage, aside from questions relating to insurance, is that it makes provision for the future introduction of the light.

The Heating Effect of the Current in Conductors.—At the last convention of the Edison Association, held at Niagara Falls, Mr. A. E. Kennelly, well known to your readers, and now at the Edison Laboratory, read a most instructive Paper on the heating effects of the current in conductors. The great value of Mr. Kennelly's work consists in the fact that he has, by actual experiments over a wide range of currents and sizes of wire, to a certain extent verified some of the laws before arrived at; and, on the other hand, he has shown wherein they fail to express the truth, and the causes which lead to this discrepancy. He also takes up the subject of the accuracy of the rules promulgated by various electrical bodies—such, for instance, as the Safety Rule of the Board of Trade and the later one of the London Institution of Electrical Engineers, and shows where incongruities arise when these rules are carried out in practice. It would take me too far to go into the whole of Mr. Kennelly's work, but the publication of these tests, which have recently been begun in the *Electrical World*, is a valuable addition to the literature of this subject. The many diagrams accompanying the Paper show very graphically the behaviour of the wires under different conditions.

Electric Power for Church Organs.—A few weeks ago Dr. Talmage's great tabernacle was destroyed by lightning, and so great is the appreciation of the electric light among Dr. Talmage's people, that in rebuilding the sanctuary they propose to have what will be, practically, the largest electric plant to be found in a church anywhere. It is a remarkable fact, worthy of note here, that throughout the country large numbers of churches are now being supplied with electric power for the operation of their organs. There are several interesting electrical plants in miniature to-day in the churches of New York City. One, for example, at the Church of the Holy Trinity, consists of a gas-engine of $\frac{1}{8}$ horse-power, a small dynamo, a storage battery, the necessary automatic cut-outs, and an

Digitized by Google

automatic battery switch. Another plant, in St. George's Church, consists of a steam-engine of ¼ horse-power, and a little dynamo of 100 watts capacity. In the electric organ of this church, the insulated wire circuits are over 37½ miles in length, and there are 438 electro-magnets. This instrument has been played electrically for nearly three years, without showing any defect whatsoever. Another organ played electrically can be found in St. Paul's Church, one of the oldest in the country. In fact, the instances of this kind are so numerous and are supplemented by so many examples of church electric lighting that, as has been remarked, the time is not far distant when an electrician will be as well recognised an adjunct to the staff of every church as the clergyman and the sexton.

The Delany Telegraph Line Adjuster. — On the same evening, Mr. P. B. Delany brought before the Institute his telegraph line adjuster, by means of which all the way stations on the line have their relays kept in adjustment, so that, practically, any interruption of traffic in any weather is made impossible. With the recent improvements made in it, it was shown at the meeting in practical operation, and elicited many favourable comments from those present. Mr. Delany also described and showed a specimen of his improved gravity cell, in which both the zinc and the copper crystals are enclosed in paper, by which much of the injurious local action is avoided.

CORRESPONDENCE.

W. T. HENLEY'S TELEGRAPH WORKS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. W. Fowler, Chairman of the Fowler-Waring Cable Company (Limited), is reported to have stated at that Company's statutory meeting on the 6th inst., "We found a place on the Thames, at North Woolwich, formerly used by Mr. Henley, a 'great' maker of cables, but long since deceased."

As this statement may be taken to imply that the late Mr. Henley ceased to manufacture cables after giving up the works Mr. Fowler referred to, I beg to state that Mr. Henley forthwith adapted adjoining works and fitted them with the most modern and approved machinery for cable-making, and that these latter works, and all Mr. Henley's patents connected with submarine and other cables, were, in 1880, sold to our Company, Mr. Henley continuing the management until his decease in 1882.

A large proportion of your readers are, of course, aware of the continued activity of these works, as amongst your readers are, no doubt, included most of our customers; but to avoid any likelihood of error we shall be glad if you will kindly insert this letter in your next issue.

As a matter of fact, since Mr. Henley's decease the Company has reaped the benefit of the great development of electrical industries, and the business has tripled or quadrupled since 1882, many tons of copper being now used per week for electric light conductors alone, in addition to which we have considerable employment in making telephone, telegraph, and other wires and cables, our out-turn of submarine telegraph cable during the present year having exceeded a thousand nautical miles.—

Yours, &c., G. SUTTON, Manager and Secretary,
W. T. Henley's Telegraph Works Company (Limited).
27, Martin's-lane, Cannon-street, London, E.C.,
December 10, 1889.

THE SMITHFIELD CLUB SHOW.

This Show was commenced on Monday last at the Agricultural Hall, Islington, London, N., and has been very fairly attended. The Show contained the usual features, but is noticeable for an almost entire absence of any display of electric light or power. We cannot but deplore the lack of enterprise shown by our electric light and fittings companies in this respect, both here and at the Royal Agricultural Society's Show at Windsor (where it will be remembered a similar apathy existed), in not taking advantage of the exceptional opportunities offered of bringing the various applications of electricity to domestic and other purposes before a section of the public who have few chances of extending their knowledge of what is being done in the direction of lighting and transmission of power. Whilst the absence of exhibits directly electrical is to be regretted, there are, however, to be seen at the Show some very fine examples of engines, &c., suitable for the electric light. Brief reference is appended to the more important of these:—

MESSRS. DAVEY, PAXMAN, AND CO.—At the firm's exhibit are an 8 horse-power improved portable engine with single cylinder, an 8 horse-power horizontal fixed engine (Class A), a 6 horse-power improved high-pressure girder engine (Class B), and a 4 horse-power "Windsor" quick-speed vertical combined engine. The latter has been specially designed to meet the requirements of electric light installations. All the wearing surfaces are very large, to allow the engine to be worked for many hours without stopping; the crank-shaft runs in three very long gun-metal bearings, and special means of lubrication are provided to enable the engine to run for long periods without adjustment. Messrs. Davey, Paxman, and Co. have supplied one of these engines for driving the electric light at Windsor Castle; and they have been employed in driving electric light machinery in London, Manchester, and Paris. Paxman's automatic expansion gear is applied to the high-pressure cylinder of each engine, and is controlled directly by the governor. The fly-wheel is made specially heavy for electric light work, and is turned on the face to receive a driving belt. The firm also show a 4 horse-power "Essex" patent vertical boiler.

MESSRS. MARSHALL, SONS, AND CO. (LIMITED).—This firm have on view, amongst their other exhibits, a new pattern self-contained horizontal fixed engine, fitted with Moore's patent crank-shaft, governor, and balanced slide valves; a new pattern independent vertical engine, similarly fitted; and a 10 horse-power (nominal) compound stationary engine erected underneath a locomotive multitubular boiler, and fitted with Hartnell's automatic expansion gear, automatic sight-feed lubricator, &c., both engine and boiler being constructed of ample strength for a working pressure of 140lb. to the square inch.

MESSRS. RANSOMES, SIMS, AND JEFFERIES.—This firm exhibit a large collection of their well-known machines and implements, among which may be mentioned a 10 horse-power long-stroke stationary engine, in which the main frame is in one casting of the circular hollow type, the engine being specially suitable for mills, factories, &c. There is also a 7 horse-power short-stroke stationary engine on cast-iron foundation, the cylinder of which, with its valve chest, is bolted to the end of the engine frame, making a strong and compact engine.

MESSRS. ROBEY AND CO. (LINCOLN).—Among this firm's exhibits is one of their well-known compound "Robey" semi-fixed engines, fitted with their patent automatic governor and link expansion gear, by which the utmost economy of steam, with perfect regularity in speed, is secured. Recent carefully-conducted tests show that Messrs. Robey's improved compound engines work with a consumption of less than 2lb. of Welsh coal per horse-power per hour when developing two and a-half times their nominal power. There are also shown an E type horizontal fixed engine, fitted with patent triple expansion gear; a D type horizontal fixed engine, and a horizontal fixed engine with medium stroke, both fitted with automatic governor and link expansion gear, for which it is claimed that practically constant speed is maintained with great variation of load. These engines are made self-contained on one massive cast-iron foundation, with which are cast the main bearings; and they take a fly-wheel on either side—a clear gain where space is limited. A new design of vertical engine and boiler combined is also shown, with the main bearings, blocks, and piston guides cast in one piece with the engine framing, as well as a vertical high-speed engine designed to work with high steam pressure, which, when used for electric lighting, is mounted on a cast-iron base plate, the other end of which carries the dynamo.

MESSRS. CLAYTON AND SHUTTLEWORTH.—No engines specially designed for electric lighting purposes are shown by this firm, but they exhibit a number of their well-known make, one of which is an 8 horse-power portable engine, fitted with jacketed cylinder and continuous feed pump, to which is attached a very efficient water-heater, a reversing eccentric which admits of the fly-wheel running in either direction, and governor and duplicate safety valves (one in locked case): the steel crank shaft is sufficiently long to receive a pulley at either end. There is also shown a 10 horse-power fixed engine erected on a metal bed-plate planed at top and bottom; it is provided, in addition to the feed pump, with a patent exhaust injector for supplying the boiler, and connected with the steam pipe is a vacuum automatic sight-feed lubricator in lieu of the usual cylinder grease cock.

MESSRS. JOHN FOWLER AND CO. (LEEDS).—This firm show their well-known type of compound semi-portable engine of 8 horse-power, specially constructed for electric lighting, and fitted with Hartnell's patent automatic expansion gear on both cylinders. It is claimed that the engine is not only economical in working, but is extremely well governed, and is incapable of exceeding by more than 1 or 2 per cent. its mean speed when the load is suddenly

Digitized by Google

removed, and will not fall below the mean speed by a greater amount when the whole load is suddenly thrown on. Messrs. Fowler and Co. also exhibit several other engines of their well-known type.

Messrs. Richard Hornsby and Sons (Limited).—This firm's exhibit includes an 8 horse-power portable engine of substantial design, with wrought-iron crank-shaft, brackets, and all the working gear and shaft made of steel, with very large wearing surfaces, and a 4 horse-power vertical winding and pumping engine, specially designed for use where breakdowns would be disastrous, and intended for work in mines. A fine example of Messrs. Hornsby's compound underneath engine is on view, of which a large number are in use for electric light purposes, and for driving machinery in workshops, &c.; the engine is said to be very economical, is fitted with sight-feed lubricator, and when used for electric lighting other special arrangements are added. A model is also shown of a fixed stationary engine made by this firm, from 8 to 100 horse-power, of a design well adapted for electric lighting purposes: it is very strong, and is fitted with Hornsby's automatic gear for economical working.

Messrs. Brown and May (Devizes).—This firm have on view two examples of the "Knight" patent paraffin oil engine, which is described as a "gas engine that requires no gas supply." It is claimed for this engine that it is suitable, amongst other things, for electric-light work.

Mr. E. S. Hindley, of Bourton, Dorset, has his usual well-arranged exhibit of small engines, most of which are of his well-known types.

Messrs. Pfeil and Co. have an excellent display of lathes, including a large variety of the "Electrician" lathes. Their exhibit, which also includes punching, shearing, and drilling machines, is one of the most noticeable in the Show.

Among the miscellaneous exhibitors who have good displays of engines, engineers' stores, &c., may be mentioned Messrs. Allchin, Linnell, and Co., of Weston-street, Northampton, who have some examples of their well-made traction engines on view; and Messrs. W. H. Willcocks and Co., of Southwark-street, London, S.E., who have a large display of machine belting, &c.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning.*]

Okonite Wire.—Okonite-covered wire has met with considerable favour in America for telegraph and telephone purposes, as well as for electric light leads. This insulation is somewhat more expensive than the usual rubber compounds, but experience has shown that it far surpasses them in durability, toughness, and resistance to the deteriorating influence of the weather. Variations of temperature, also, have but little effect on its insulating properties. In Chicago, where there are some 80 miles of okonite insulated wire in use in the electrical conduits, it has been exposed to an exceptionally severe test without breaking down. The wires in Chicago are run underground in the sewers on brackets coming out from the wall with the ordinary common glass insulators, and when the Chicago river is in flood the wires are completely under water. As the E.M.F. averages about 2,000 volts the test is sufficiently severe. The sole agents in this country of the Okonite Company, of New York, are Messrs. Laing, Wharton, and Down, of New Bond-street.

Chemicals for Batteries.—Several samples of sal ammoniac and chloride of ammonium, for batteries, manufactured by the Netham Chemical Company (Limited), of Bristol, can be seen at this office.

The Consolidated Telephone Construction and Maintenance Company (Limited).—This Company have recently issued an illustrated circular giving descriptions and prices of their telephones for domestic use. It should be noted that these telephones are for export only. Among the illustrations is a diagram showing this system of domestic telephony.

The General Electric Company (Limited).—We are in receipt of four electrical engineering cards issued by this Company, giving price-lists and illustrated descriptions of Edison fittings, flexible cords for table and pendant lamps, porcelain ceiling rosettes, pendant accessories, brass galleries and caps, jointing materials and sundries.

Messrs. John Davis and Son.—We have recently received two catalogues (A and B) from this firm. The A catalogue deals with mining, mathematical, surveying, and engineering instruments, and miners' safety lamps; the B catalogue deals with electric light plants, transmission of power, electric blasting apparatus, electric signalling apparatus, special outdoor fittings for electric lamps, lightning conductors, &c.

Messrs. J. G. Statter and Co.—This firm's recent list includes tabulated particulars relating to the "Statter" dynamos and motors, with illustrations of both, as well as of a combined engine and dynamo for ship lighting, or for use where space is limited.

Messrs. Poole and White.—This is the title of a new firm of electrical and mechanical engineers with offices at 58 and 59, Bread-street, Cheapside, London, E.C.

Personal.—Mr. W. C. Muir, has, we are informed, withdrawn from the firm of Messrs. Muir, Mavor, and Coulson, of Glasgow.

Tenders Wanted.—The Shropshire Iron Company (Limited) are asking for tenders for lighting. Particulars will be found in our advertisement columns.

Sales by Auction.—We would remind our readers that Tuesday next, the 17th inst., is the date fixed for the sale by Messrs. Wheatley Kirk, Price, and Goulty of the stock and stores of Luther Hanson and Co. (Limited), in liquidation. The sale takes place at North Bridge Electrical Works, New Bank, Halifax, and commences at 10 for 11 o'clock prompt. The catalogues are now ready, and can be obtained of the auctioneers, or of Mr. James Duff, the official liquidator, Barum House, Harrison-road, Halifax. The sale includes the patent rights, patterns, and drawings for the Luther dynamo and arc lamp, as well as a number of new dynamos, one of which was successfully run at the 1887 Manchester Exhibition.

——— Mr. Joseph Dawe will sell by auction, at the Mart, Tokenhouse-yard, London, E.C., on Wednesday next, the 18th inst., at 2 o'clock, the British and foreign patent rights of Douse's Fire-checking Apparatus. Further particulars will be found on page iii. of advertisements.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

November 14, 1889.

18,172. J. H. Tucker. Birmingham. Improvements in china or porcelain electric light fittings.

November 15, 1889.

18,261. R. J. H. Rastrick. London. Improvements in and relating to the construction of joints for telegraphic, telephonic, and like wires.

18,269. W. P. Thompson. Liverpool. Improvements in or appertaining to electric motors (L. Gutmann, United States).

November 16, 1889.

18,322. J. G. Cumming. Glasgow. Improvements in electrical coin-freed machines.

18,343. Siemens Bros. and Co. (Limited). London. Improved safety apparatus for a network of multiple electric conductors (the firm of Siemens and Halske, Germany).

18,530. J. H. Davies. Grays. Improvements in dynamo-electric machines.

18,355. J. D. Gibbs and E. Fresquet. London. Improvements in secondary generators, transformers, or converters of electricity.

18,360. W. Renshaw. London. Improvements in dynamos.

18,361. S. Ziani de Ferranti. London. Improvements in electric meters.

18,362. S. Ziani de Ferranti. London. Improvements in electric locomotives and other variable speed electric motors.

November 18, 1889.

18,365. J. B. Entz and W. A. Phillips. Manchester. Improvements in and connected with plates for primary and secondary batteries.

18,377. R. Armstrong. Lasswade. Improvements in signal and telegraph apparatus.

18,414. J. Hopkinson. London. Improvements in electrical tramways or railways.

November 19, 1889.

18,439. W. H. Dines. Surrey. Recording the strength of an electric current.

18,431. C. Payen. London. Improvements in secondary or storage batteries.

18,521. H. T. Tallack. London. Improvements in telephone receivers.

18,526. H. H. Lake. London. Improvements relating to the transmission and reception of telegraphic signals and to apparatus therefor (S. D. Field, United States).

November 20, 1889.

18,550. E. Simpkin. Manchester. Improvements in electric heaters (W. L. Burton, United States).

18,571. J. C. Richardson and H. McKenna. London. Improvements in the construction of conduits for carrying electric light and other electric lines or cables.

18,578. S. W. Maquay. London. Improved apparatus for registering the consumption of the electric current.

Digitized by Google

SPECIFICATIONS PUBLISHED.

1888.

18,137. HARTNELL. Switches for electrical currents. (Price 11d.)
18,784. LAHMEYER. Regulating electric currents, &c. (Price 11d.)
18,825. COCKBURN. Electric switches. (Price 8d.)
18,855. SHEFFIELD and LOWENSTEIN. Printing telegraph. (Price 8d.)
13,908. GOODFELLOW and CHARLES. Electric arc lamps. (Price 6d.)
18,966. TIMM. Telegraphic transmitters. (Price 8d.)
18,978. BUSH. Storage batteries. (Price 4d.)
18,981. DOUBLEDAY. Electrical storage batteries. (Price 4d.)
19,045. HANDFORD (Western Electric Company). Telephone call apparatus. (Price 8d.)
19,058. JOHNSON (Gendron). Electric batteries. (Price 8d).

1889.

85. POLESCHKO. Dynamo-electric machines. (Price 8d.)
126. LÜCKOFF. Dynamos. (Price 6d.)
997. CUTTRISS. Secondary batteries. (Price 6d.)
7,919. GROCOTT. Electric lamp roses, switches, &c. (Price 8d.)
12,615. PATTEN. Dynamo-electric machines. (Price 8d.)
12,815. ANDERSEN and GIRDLESTONE. Electric motors. (Price 8d.)
13,480. KOOKOGEY. Charging storage batteries. (Price 8d.)
13,541. BONNE (Mix and Genest, Limited). Electric wire and pole connectors. (Price 6d.)
13,557. JOHNSON (Collier). Electric lamp-holders. (Price 6d.)
13,841. WHELESS. Telephonic, &c., apparatus. (Price 8d.)
13,864. CURRIE. Secondary batteries. (Price 8d.)
14,279. HADDAN (Conkling). Magnetic separators. (Price 6d.)
14,280. HADDAN (Conkling). Separating magnetic from non-magnetic particles. (Price 6d.)
14,333. ARNOLD. Incandescence lamp. (Price 6d.)
14,565. DRAPER and ASH. Recording telegraph signs, &c. (Price 6d.)
14,593. CAMPBELL. Metallic circuits. (Price 6d.)
14,601. MACAULAY-CRUIKSHANK (Barrett). Electric batteries. (Price 6d.)
14,666. RENO. Electric conduits for street railways. (Price 8d.)
15,045. DORMAN and SMITH. Electric switches, &c. (Price 8d.)
15,383. HEYL. Secondary batteries. (Price 4d.)
15,446. CURRIE. Electrical accumulators. (Price 8d.)
15,819. SMITH. Electric batteries. (Price 8d.)

Second Edition.

1,904. KAPP and others. Transformers. (Price 8d.)

Second Edition.—1883.

5,926. DE FERRANTI. Electric machines, &c. (Price 1s. 6d.)

Amended Specification.—1883.

5,992*. CLARKE. Lighting gas by electricity. (Price 8d.)

COMPANIES' MEETINGS & REPORTS.

The Fowler-Waring Cables Company (Limited).

The first general meeting of this Company was held on the 6th inst., at Winchester House, Old Broad-street, under the presidency of Mr. William Fowler.

The SECRETARY (Mr. Geo. Neill) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, you are aware that this is not a meeting for business. It is merely a formal meeting, under the Act of Parliament, which we have to hold within four months of the formation of the Company. You will understand that, immediately the Company was formed, the first point we had to consider was, where shall we proceed to work and arrange for procuring the machinery and everything necessary for the work of the Company? We decided, if possible, to have our work commenced in London, and after a great deal of inquiry we found a place on the Thames at North Woolwich, formerly used by Mr. Henley, a great maker of cables some years ago, but who is long since deceased. It is a curious fact that in Mr. Henley's time I went down to see that place and his works, and when it was suggested to me that this place, so long idle, would be suitable for us, I said I thought so too, for, unless I was mistaken, Mr. Henley was a man who did everything very well. We, therefore, after a great deal of consideration, made a contract with the owners of this property, giving us the property for a certain time at a very moderate rental, with an option at any time within four years to buy the freehold at a rate which is just about 20 years' purchase of the land. Of course, when I say the land, I mean the land and all the buildings upon it which Mr. Henley had put up. Last week I renewed my acquaintance with the place after we had done a great deal upon it, and I assure you I was astonished at finding how accurate my memory had been, for the character of the building was such that I am certain we have made a most excellent bargain. I say so without hesitation, because its acquisition was owing more to others than to myself, though I gave it my hearty sanction when I understood the terms that were suggested. It will, of course, cost us something to place the buildings in condition to carry on our business, but the expenditure will not be very material. They have been made so substantially, and they are so grand in their way—if I may use such an expression relative to buildings for manufacturing purposes—that I really believe it would cost you all the money that we shall have to pay for the property, if we buy it, to put up these buildings to-day. I therefore think that we have not lost any time, and that we have done a work for you which will be very satisfactory to you in the result. The machinery is actually, to some extent, on the place. The engine and boilers are up this very day, the shafts are turning round, and I believe that very early in the next year, 1890, we shall be in a position to take orders for cables. Of course, as you are aware, from the prospectus, we have not been without business in the meantime, because under the arrangements with the firm of John Fowler and Co., of Leeds, they hand over to us the profit on their business, less a fair percentage for their work, and they have been busily making cable ever since the time the Company was formed. We are therefore really earning some money now, and I have very little doubt—I think I may say I am confident—that this Company will be a real success. I am extremely cautious about making promises or prophecies, as I think both are very dangerous things, but I believe we have got hold of a business which will prove very satisfactory to you as shareholders. I really do not know that there is anything else I can say. I repeat that we have not lost an hour in endeavouring to set to work, and we are likely to be at work practically within four months of the formation of the Company. I think we could not very well have done more than that. It is only through the accident of finding this place all ready for use that we are enabled to make that statement. If we had had to buy land, and put up buildings, I really do not think we should have done it under a year; but as it is, we are very likely, as I said, to be at work four months from the time of the formation of the Company. I have no resolution to propose, but merely to make this general statement as to the condition of the concern; but I shall be delighted to answer any question that any shareholder may have to put to me.

Mr. POTTER stated that through him a considerable number of the shares of the Company had been taken in Leeds, and recently something had occurred there which had rather exercised the minds of several of the shareholders, and his own, too. They understood that the Fowler-Waring mode of making the cable with the covering of lead was the only one there was, and that the patent rights were secured to this Company. At the

PATENT
SILICIUM BRONZE AND SILICIUM COPPER WIRE.
The best for overhead Telephone and Telegraph Lines,
AND ALL ELECTRICAL PURPOSES.
Hard Drawn High Conductivity Copper Wire.
ROLLED AND DRAWN
PHOSPHOR BRONZE.
PHOSPHOR BRONZE
PHOSPHOR BRONZE
BEARINGS, BUSHES,
AND OTHER PARTS OF
ELECTRICAL MACHINERY.
SOLE PROPRIETORS of the British, Indian and Colonial Patents,
THE PHOSPHOR BRONZE COMPANY (Limited),
87, Sumner Street, Southwark, London, S.E.
WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

Digitized by Google

present moment, however, in Leeds, cables were being laid which appeared to be nearly the same thing; and to relieve the minds of several of the shareholders who had been to him, he would like to ask if that were the same thing, seeing that they had been under the impression that this Company had the monopoly of the patent. Mr. Eddison would know what he was referring to. The cable in question had been laid near the Queen's Hotel. The core of the thing appeared to be the same; but it seemed to be lead-covered cable like the Fowler-Waring. He spoke himself without knowledge of the thing, and only because several persons had been to him and asked him if he could find out anything about the matter.

The CHAIRMAN: I will ask Mr. Eddison to answer the question.

Mr. EDDISON: The cable you refer to as being laid at the present time in Leeds is one that has been supplied from Chicago by the Western Electric Company to the National Telephone Company—a 100-wire telephone cable. The wires are covered with lead, but they are drawn into lead pipes, whereas we put the covering on the lead; and the covering in the case of the American wires is in very short lengths. I may also add that the National Telephone Company have given us an order for Leeds. One cable will be laid next week, and it is double the length of the Chicago cable.

Mr. POTTER said he had thought it only his duty to ask the question.

The CHAIRMAN: I am glad you did so, but I think it is clear from what has been just said that the American cable is totally different from ours. If we found anyone infringing our patent we should soon bring him to book.

Mr. EDDISON: If you examined the American cable you would find a plumber's joint every 40 feet.

The CHAIRMAN: We, of course, must not begin an action until we are quite certain that our rights are being infringed.

We will now consider the statutory meeting closed, and I have to move a formal resolution as to a change in the Articles of Association which is demanded by the Stock Exchange before we can get a settlement. He then proposed a resolution, making certain alterations in Clauses 31 and 77 of the Articles of Association.

Mr. FLEMING seconded the resolution, which was unanimously agreed to.

The CHAIRMAN stated that that closed the business of the meeting. It would be necessary to hold a meeting to confirm the resolution just passed, and they proposed to hold it on the 20th inst. at the offices of the Company, when he hoped that a few gentlemen would be kind enough to attend to form a quorum. It was only a formal matter, but it had to be gone through so as to get the settlement on the Stock Exchange.

Mr. GATHORNE-HARDY then proposed, and Mr. POTTER seconded (at the same time expressing his satisfaction at the business-like conduct of the meeting), a vote of thanks to the Chairman.

The CHAIRMAN, in reply, assured the shareholders that, for many reasons, he would do all in his power to make the Company a success.

The Gülcher (New) Electric Light and Power Company (Limited).

The following is the report of the Directors of this Company for the year ended June 30th last. The Directors state that they are now able to present to the shareholders the first balance-sheet, for the twelve months ended June 30, 1889, of the reconstructed Gülcher Company. The shareholders are already so well acquainted with the conditions of the reconstruction of the Company that the balance-sheet calls for but few observations. Although the agreement for sale by the liquidator of the old Company was signed on February 23, 1888, the new Company was unable to complete its purchase until August 31, 1888, and, therefore, had been on June 30, 1889, in existence as an actually trading company for ten months only. The Second Debentures were issued to enable the Company to carry out the lighting of the City of Wellington, New Zealand. The value at which the New Zealand contract is assessed in the balance-sheet is the actual cost price expended in time and materials on June 30, 1889. The central stations at Wellington were finished in the month of September last, and the public lighting has proved to be thoroughly satisfactory. The commercial success of this undertaking will depend entirely upon the ability of the Company to provide capital for private lighting. The Directors have laid down plant capable of distributing the current to the remotest parts of the city, and with a comparatively small further outlay a remunerative revenue could be obtained. The Directors propose to carry forward the surplus appearing to credit on the balance-sheet. Particulars of other contracts undertaken and carried out during last year will be supplied at the general meeting, when a detailed profit and loss account will also be submitted to the shareholders. Several alterations have taken place in the Board of Directors since February 23, 1888, but all the Directors on the Board at present are original Directors of the Company. This being the first general meeting of the Company, all the Directors retire, but, being eligible, offer themselves for re-election. The Directors having appointed Mr. Russell Day, formerly secretary of the Gülcher Company, to investigate, on their behalf, the accounts involved in the transfer of the Gülcher Company's business to them, decided to appoint him to audit the first balance-sheet and profit and loss accounts. It will be for the shareholders to appoint an auditor or auditors for the ensuing year.

NEW COMPANIES REGISTERED.

FOREIGN AND COLONIAL ELECTRICAL POWER STORAGE COMPANY.—Objects, to carry on in any part of the world the business of manufacturing and working storage batteries and machinery, and the use of electric, magnetic, or other force, adopting therefor an agreement (unregistered) of November 22, 1889, made with the Electric Construction Corporation, Limited. Capital, £100,500, in £5 shares, of which 100 are founders' shares. Subscribers of one ordinary share each are: Sir Daniel Cooper, Bart., G.C.M.G., J. Irving Courtenay, James Balfour, James Pender, J.P., Frederick Green, Reginald Mackenzie, T. H. Horwood. Directors (three to seven), Sir Daniel Cooper, John Irving Courtenay, James Pender, James Balfour, and Frederick Green, as above named, the first mentioned three not acting until after adoption of agreement. Qualification, £500, in shares or stock. Remuneration, £1,000 per annum, and 10 per cent. of profit after 10 per cent. dividend; total, however, not to exceed £5,000 in any year, and such sums are to be divisible. Directors may borrow on mortgage debentures to the extent of £100,000 without sanction of general meeting. Registered, December 3rd, by Renshaws, solicitors, 2, Suffolk-lane.

MORRIS BROTHERS (LIMITED).—The Company was registered on the 5th inst., with a capital of £5,000, in £1 shares, to acquire the business of Messrs. Morris Brothers, of Hartington Works, Branston-street, Birmingham, electricians and general scientific apparatus manufacturers. Registered without special articles. Solicitors, Messrs. Kerly, Son, and Verden, 14, Great Winchester-street, E.C.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended December 6th amounted to £4,944.

ROCHESTER, CHATHAM, AND DISTRICT ELECTRIC LIGHTING COMPANY (LIMITED).—The second annual report of the Directors of this Company announces that although unable to show a profit out of which to declare a dividend, it is now felt assured that the business is established on a commercially sound and fairly remunerative footing. Quite two-thirds of the lights have been applied for and are now installed, and, as orders are still coming in, it is hoped by the end of the year that the remainder will be disposed of. A change has taken place in the management of the works by the resignation of Mr. Parker and the appointment of Mr. A. Maund.

STOCK EXCHANGE.—The Committee have appointed Tuesday, the 17th inst., the special settling day in the Electric Construction Company (Limited)—shares, Nos. 101 to 45,100; and the National Telephone Company (Limited)—49,825 additional shares, Nos. 386,876 to 436,700 (to be quoted in the official list).

WESTMINSTER ELECTRIC SUPPLY CORPORATION (LIMITED).—The issue was announced on Friday last of 60,000 shares of £5 each, of which 20,000 have already been taken.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended December 6th, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,538.

THE NON-CONDUCTOR OF ELECTRICITY.

WAREHOUSE.

VULCANISED FIBRE,

PATENTED.

This new material is supplied in two qualities, Flexible and Hard.

The FLEXIBLE is a substitute for Leather, Rubber, Gutta Percha, &c., and is extensively used by Brass Founders, Axle Makers, Hydraulic, Sanitary, and other Engineers, Pump Makers, Carriage Builders, &c.

It makes the best Hot and Cold Water Packings, and for Axle Washers of all kinds it is unequalled.

The HARD is a substitute for Metals, Hard Wood, Ivory, Vulcanite, Ebonite, &c., and is a good Insulator.

Sold in sheets, 5ft. 6in. by 3ft. 6in., varying in thickness from 1-50in. to 1in.

FACTORY.

FLEXIBLE, 2/- per lb.; HARD, 2/3 per lb.

MOSSES & MITCHELL, 70 Chiswell-st., London, E.C.

Digitized by Google

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Wednesday, Dec. 11, 1889.	Rate per cent. Yielded.	Dividend Due.	Business done during Week Ending Dec. 11, 1889.	
£			**TELEGRAPHS.**		£ s. d.		Highest.	Lowest.
1,770,360	Stock	12/6	Anglo-American	52½ 53½	5 2 10	Jan., Apr., July, Oct.	53	52⅜
2,614,820	Stock	25/0	Do. Preferred	87½ 88½	6 4 4	,, ,,	88⅞	87½
2,614,820	Stock	...	Do. Deferred	17⅞ 18	...	February	17⅜	...
130,000	£10	4/0	Brazilian Submarine	12⅛ 13	5 15 5	Mar., June, Oct., Dec.	12⅜	12⅛
112,900	£100	5%	Do. 5 per Cent. Bonds	101 103	4 16 9	January and July	...	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	106 109	4 11 9	June and December.	...	...
16,000	10	9/0	Cuba Submarine	14⅛ 15	6 0 0	February and August	15	...
6,000	10	10/0	Do. Preference 10%	19½ 20½	4 19 9	,, ,,	...	...
12,931	5	2/0	Direct Spanish (£4 paid)	3⅜ 4⅜	3 15 4	March & September	...	...
6,000	5	5/0	Do. Preference 10%	9 10	5 0 0	April and October	...	...
60,710	20	3/6	Direct United States	10¼ 10⅜	6 10 3	Jan., Apr., July, Oct.	10⅜	10¼
380,000	10	2,6	Eastern	13¾ 14⅛	4 12 0	,, ,,	14	13⅛
70,000	10	3/0	Do. 6 per Cent. Preference	15¼ 15⅝	3 16 2	,, ,,	15⅜	...
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock	106 108	3 14 1	May and November.	107⅛	106
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	107 110	4 10 11	February & August	...	...
250,000	10	2/6	Eastern Extension	13⅞ 14	4 12 10	Jan., Apr., July, Oct.	14	13⅞
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	102 104	3 16 1	February & August	...	...
473,000	100	5%	Do. 5 per Ct. (Austrln. Gov. Sub.) Debs. 1900	104 107	4 13 6	January and July	...	...
179,177	10	2/0	Globe Telegraph and Trust	8⅝ 8⅞	5 3 9	Jan., Apr., July, Oct.	8⅞	8⅛
178,992	10	3/0	Do. 6 per Cent. Preference	14⅝ 14⅞	4 0 8	,, ,,	14⅞	14⅝
150,000	10	5/0	Great Northern	15⅞ 16⅛	4 12 4	Jan., July, and April	16⅛	16⅛
17,000	25	12/6	Indo-European	41 43	5 16 3	April and October	...	...
9,000	8	4/0	Reuter's	7 7½	5 6 5	April and October	...	...
15,609	10	5/0	West African Telegraph	9½ 10½	...	...	...	...
300,000	100	5%	Do. 5 per Cent. Debentures	99 102	4 18 0	March & September	101½	...
30,000	10	5/0	West Coast of America	10⅛ 11	5 0 0	January and July	10⅝	10¼
150,000	100	8%	Do. Debentures 8%	123 128	6 5 0	June and December	...	...
88,321	10	nil.	West India and Panama	2⅞ 3⅜	...	...	3 1/16	3
34,563	10	12/0	Do. 1st Preference 6%	11½ 12	...	April and October	11¾	11½
4,669	10	10/0	Do. 6 per Cent. 2nd Preference	14⅛ 15½	...	...	9⅞	...
45,181	15	6/0	Western Brazilian	9¾ 10¼	7 6 5	May & November	9⅛	9⅝
$1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	118 122	5 14 9	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	100 102	5 17 2	March & September	...	...
			TELEPHONES.					
224,850	14/0	5%	Consolidated Telephone and Maintenance	⅝ ¾	5 0 0	Yearly	...	...
220,000	£1	3%	Oriental (11s. paid)	1/16 1/16	3 15 11	...	...	...
*	*	...	National	5⅛ 5⅜	...	...	5⅝	5¼
55,000	5	3/0	United River Plate	4¾ 5¼	...	January and July	...	...
			ELECTRIC LIGHT.					
23,692	5	2/0	Anglo-American (fully paid)	...	...	February & August	...	...
79,934	5	6%	Swan United (£3. 10s. paid)	4⅜ 5¼	4 0 0	...	5⅛	4⅞
500,000	10	...	Metropolitan Electric Supply (£3 paid)	4½ 5	...	...	5⅛	4⅝
			MISCELLANEOUS.					
87,350	12	12/0	Telegraph Construction and Maintenance	44 46	5 4 5	March and July	47¼	44½
41,600	10	10/0	India Rubber, Gutta Percha & Telegraph Works	17½ 18½	5 8 1	February & August	18⅜	17¼

JABLOCHKOFF'S
DISTRIBUTION PATENT

(Being a Patent for "Producing and Dividing Electric Light," No. 1996 of 1877.)

THE UNITED ELECTRICAL ENGINEERING COMPANY (LIMITED)

Are Proprietors of the above Patent, and Warn the Public against Infringement.

The following are Licensees:—

Anglo-American Brush Electric Light Corporation, Limited.
Crompton & Co., Limited.
S. Z. de Ferranti.—London Electric Supply Corporation, Limited.
W. T. Goolden & Co.
Hammond & Co.
Wilson Hartnell.
Johnson & Phillips.
Laurence, Paris & Scott, Limited.
Nalder Brothers & Co.
Paterson & Cooper.
Ernest Scott & Co.
Siemens Brothers & Co., Limited.
J. G. Statter & Co., Limited.

3, Prince's Mansions, Victoria Street, Westminster.

MANVILLE & MADGEN, *Managing Directors.*

Digitized by Google

THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 605.—Vol. XXIV. FRIDAY, DECEMBER 20, 1889. Price Fourpence.

NOTES.

It will be remembered by our readers that at the beginning of the present year (*Electrician*, March 22nd) Mr. Edison's Canadian incandescent lamp patent was cancelled by the Commissioner of Patents, on the ground that it was void from failure to manufacture in the Dominion within two years, as required by law. Owing to a doubt as to the jurisdiction of the Commissioner, the action was reheard, and a decision maintaining the validity of the Canadian patent has now been given by the Minister of Agriculture. As it is uncertain what is the exact legal effect of the expiry of a foreign patent upon one held in the United States, this result will tend to still further strengthen the Edison patent in America.

For a Company which has not yet been two years in existence, and which has only been able to get fairly to work within the last five months, the record of the Metropolitan Electric Supply Company, as set forth in the report of the Directors, is very creditable. The capacity of the three existing central stations is taxed to the utmost, and although the stations at Manchester-square and Waterloo Wharf are expected shortly to come into operation, the Directors deem it advisable, in view of the increasing demand for current, to double the plant at Sardinia-street, and to commence the construction of a station within the Strand district. Additional stations are, moreover, contemplated for the City and Paddington. Such substantial progress as this is most encouraging. A coloured map, which is issued with the report, shows the areas allotted last Session to the various electric supply companies; and it brings out very clearly that, as far as mere size is concerned, the lion's share of the lighting of the metropolis has certainly fallen to the Metropolitan Company and the London Electric Supply Corporation.

The proposal for a partial amalgamation of the five leading engineering societies, which was brought forward by Major Flood-Page at the annual general meeting of the Institution last Friday, does not, it seems to us, contain the elements of success. United action for temporary purposes may often be very advantageous, but the tendency of the times points, we think, far more towards sub-division than amalgamation. A second proposal of Major Flood-Page was that the Institution of Electrical Engineers should undertake examinations and issue certificates of competency as electrical engineers. Whether the goal aimed at be an improvement in the present standard of admission to the Institution, or merely the weeding out of incompetent workmen, we think the Council would be ill-advised if it were to adopt this suggestion. The former object would, we are confident, be better attained by a more rigorous scrutiny of the claims of the candidates for admission, while the task of weeding out incompetent workmen falls more within the province of our technical schools than of the Institution of Electrical Engineers.

We commence this week a series of articles on "Magnetism in Iron and other Metals," from the pen of Prof. Ewing, whose researches in this direction are too well known to need comment. At a time when the phenomena connected with the magnetisation of iron have assumed such prominence in practical work, we venture to think that this series will prove especially interesting and instructive.

The sensational stories of deaths from electricity which are being telegraphed almost daily by the New York newspaper agencies to this country would be simply absurd if they were not so inconveniently inopportune. Even if they were true, which in most cases they are not, and even if the "pathological" comments on the victims were as edifying as they are ridiculous, there is no apparent reason why a death from electricity, any more than a death from inebriety, should be proclaimed all over the two continents. The chief reason we take to be that the people of New York, not before time, have become disgusted with the hideous disfiguration of their thoroughfares by the indiscriminate erection of poles and wires to a quite intolerable extent, and are glad to seize on any pretext for getting rid of the nuisance. But we are not afflicted in any such degree on this side the Atlantic, and our American brethren might have a little mercy on us who are only just feeling our way with electric lighting, and whose intending customers are likely to be scared by the accounts that reach them from a quarter where it has long been well established. If New York electrical engineers are so negligent, or so incompetent, as to leave their wires in a dangerous condition, the least they can do is to keep their servants out of harm's way.

As an example of how little electricity has to do with many of these sad accidents in which the American daily press takes such morbid delight, we cannot do better than quote the following from our esteemed contemporary the *Electrical World*

Digitized by Google

of New York:—"A few days ago a sensational paragraph went the rounds to the effect that a boy at Chattanooga, while under one of the cars, cleaning it, made contact accidentally with the current wires and was killed. As only 500 volts is used on electric roads, the story seemed apocryphal, but it 'went.' The true account of the accident now shows that no current was on at all at the time. The coloured boy in question was under the cars, wiping off the motors with waste. A groan was heard, and then some men at work in the shed found that the boy had fallen asleep, tipped his lamp over and set fire to the waste and to his clothing. He died from the burns six weeks later. Nearly all the 'electrical accidents' we have investigated have turned out to be of this nature, and we are becoming rather tired of exposing them."

It is announced by our American contemporaries that a fusion has been effected between the Edison General Electric Company and the Sprague Electric Motor Company, between which bodies a friendly alliance had long subsisted. Mr. Edward H. Johnson, whose business ability in pushing the Edison interests is so well recognised on this side the water, has also for some years been President of the Sprague Company, and it is to his exertions that the amalgamation of interests is due. In a recent interview on the subject, Mr. Johnson stated two points, to each of which, though for very different reasons, we draw the attention of our readers. He stated that many of the Edison generating electric stations were now not primarily electric lighting stations, though originally established as such, for so great had been the development in the use of electric motors in the various industries that the main work of the stations was now to supply electric motive-power. He maintained that the motive-power business was rapidly rivalling the lighting business, and would unquestionably surpass it in the near future in the amount of capital employed and in output. We commend this first point to our English readers. It does not surprise us: but it is a good sign.

Mr. Johnson's second point is, however, surprising. "He claims that, based as they both unquestionably are upon fundamental patents—Edison for generating and distributing and converting into light, and Sprague for distributing and converting into power—it requires no great stretch of the imagination to foresee a future for the combination equalled by no new industry, not excepting the telephone, which this most fruitful of inventive nations has yet produced." If the words, which we quote verbatim, have any meaning, they imply that Edison is the inventor not only of the glow-lamp, but also of the arc lamp, the dynamo, and of the means of distributing currents; whilst Sprague is the inventor of the electric motor, and that no one else will be allowed to distribute light or power in the States. Now, whatever is the extent of Edison's claim to the invention of the glow-lamp, he certainly did not invent the arc lamp, nor the insulated wire conductor. And as for the dynamo, were not the dynamos of Gramme, Siemens, Brush, and Thomson-Houston at work at the date when Edison was racking his brains over his tuning-fork dynamo and his Faradaic machine? And with regard to Sprague, is it not well known that Gramme's and Siemens's machines were in use as motors before that distinguished officer had even begun his electrical studies in the Naval Academy? whilst it is notorious that the so-called Sprague method of winding motors with a series coil to weaken the field-magnet, which he invented in 1884, was described by Ayrton and Perry in 1882. Mr. Johnson's broad claim to control the motor industry by Sprague's patents is a little too broad. We commend this, his second point, to our American readers.

Our enterprising evening contemporaries, who eagerly snap up what they suppose to be news about electrical discoveries, have been busy circulating a report to the following effect:—It is well known that in every primary battery part of the current never gets out of the battery, but is wasted, and that there is consequently a waste of the zinc: a remedy for this has just been found by the great Mr. Edison, who, after thousands of experiments, has succeeded in discovering a simple fluid which has the remarkable property of preventing the useless consumption of the zinc. It now turns out that this "simple" fluid is a solution of caustic potash, and that the depolarising agent is compressed oxide of copper. Did no one ever hear before of the Lalande-Chaperon cell, in which these very substances are used? We were promised electricity for nothing and a profit out of the value of the waste products. What more could one want? Only this time when the great invention turns up again, it has got the great patentee's name upon it. *O sancta simplicitas!*

Our readers will find to-day another instalment of Mr. Kennelly's valuable Paper upon "The Heating of Conductors by Electric Currents," and right good reading it is, being the record of careful, intelligent, and thoroughly scientific work. Mr. Kennelly confirms Forbes's point that whilst the loss of heat by radiation proper is very nearly proportional to the elevation of temperature of the surface, the loss by convection currents in the surrounding air is by no means so. We heartily applaud Mr. Kennelly's researches, and wish he may long live to carry out such useful work.

Mr. Kennelly does not mention—though for all that he probably is not ignorant of—some researches on the heating of wires made by Mr. J. T. Bottomley, of Glasgow, some years ago, and which were communicated at the time to the Royal Society. Amongst other curious results brought out by Mr. Bottomley was the effect of an insulating coating upon thin wires: he showed that it was possible, using a conducting copper wire coated with an electric insulator, so to arrange the relation between the dimensions of the wire and its coating, the conductivity of the material and the emissivity of the surface, that the presence of the insulator shall keep the wire *cooler* than it would be without the coating. This curious experimental result had been predicted from theory by Sir William Thomson. Writing of this to the Editor of this Journal some time back, Mr. Bottomley recalled the king, in

Digitized by Google

"Faust," who had "a lusty flea," remarking that if the jacket ordered by the king for a creature of such minute dimensions had been of flannel, it would have kept him *cool*, not warm!

On Friday last Mr. Joseph Frederick Leeson, who was recently struck off the register of general practitioners by the General Medical Council, for acting as cover to Mr. Harness, brought a motion to restrain the Council from erasing his name from the register until the trial of the action which he is bringing against them. In support of the motion it was urged that the Council had not complied with their own rules, that certain matters had been before the Council which were not evidence, and that two of the judges were members of the Medical Defence Union. Mr. Justice North briefly put aside the first two reasons, and decided that, although the members of the Medical Defence Union were interested in the case, their interest was not of a pecuniary nature. The motion was, therefore, refused.

Volume I. of "Practical Notes for Electrical Students," by A. E. Kennelly and H. D. Wilkinson, is now ready. The first volume deals with batteries, potential, resistance, current and current indicators, tests and calibration work, and magnetic fields. This work is mainly a reprint of the series of articles entitled "Letters for Learners and Un-Professional Readers," which have recently been appearing in the columns of this journal. Our readers are, therefore, in a position to judge of the style and scope of the work. The price of Vol. I. is 6s. 6d., and it is published at *The Electrician* office.

Dover.—The Town Council has decided to proceed with their application for a Provisional Order.

Cambridge.—The Town Council has resolved to proceed with their application for a Provisional Order.

Portsmouth.—The Town Council has resolved to proceed with their application for a Provisional Order.

Royal Institution.—The first of Prof. Rücker's series of six lectures on "Electricity" will be delivered at the Royal Institution on Saturday, the 28th inst., at 3 p.m.

Rochester.—The Town Council have instructed Mr. Moulton, Q.C., to give the Corporation his opinion on a proposed Provisional Order of the Chatham Electric Light Company.

The Royal Society.—Among the Papers down for reading yesterday at the Royal Society was one by Mr. C. Chree, "On the Effects of Pressure on the Magnetisation of Cobalt."

Dunedin (New Zealand).—The Gülcher Electric Light Company, having completed the work of illuminating Wellington by the electric light, have now submitted proposals to the Dunedin City Council.

Ipswich.—The lighting of the Suffolk Cattle Club Show at Ipswich, which gave general satisfaction, was carried out by Mr. W. Sisling, the Ipswich representative of Messrs. Laurence, Paris, and Scott.

The Overhead Wire Agitation in New York.—Telegrams from New York state that the cutting down of the overhead electric lighting wires has recommenced, the injunction restraining the authorities having been removed.

Postal Telegraph Revenue.—The total receipts from the telegraph service paid into the Exchequer from April 1st to December 14th of the present year, amounted to £1,630,000, against £1,470,000 for the corresponding period.

Bristol.—The Electric Lighting Committee of the Town Council have requested Mr. Preece to furnish them during the present month with an estimate and specification for lighting the portion of the city described in his report as Section A.

The Liverpool Physical Society.—The meeting at which this Society was constituted was well attended. Nearly ninety names were at once handed in to the secretary for membership. Prof. Oliver Lodge, F.R.S., was appointed president, and on Monday next delivered his inaugural address.

Chester.—In moving the adoption of the recommendation of the Watch Committee, that the electric lighting Provisional Order be proceeded with, Alderman Johnson said they were in no hurry about it, but before the period over which the Order would extend expired perhaps something more would be known about electric power.

Bradford.—At the last meeting of the Gas and Electricity Committee of the Bradford Town Council, Alderman F. Priestman said the committee had no intention whatever of extending the electricity works at present. The committee would have a full load on their present installation before Christmas, the demand for current increasing every day.

Presentation to Prof. Tait.—In consideration of his long and eminent services as secretary of the Royal Society of Edinburgh, it has been resolved by the Council of that body to present Prof. Tait with his portrait. The commission has been given to Mr. George Reid, R.S.A., and the portrait is intended ultimately for the rooms of the Royal Society.

Electric Lighting Notices.—In the list of electric notices published in our issue of December 6th, the two companies who have applied for powers for Edinburgh should have been (i) the Scottish Electric Supply Company, and (ii) the Scottish House-to-House Electricity Company, the Brush Company not having taken the necessary steps required by the Board of Trade.

Electric Traction in Italy.—A Company, called the "Società Anonima della Tramira Elettrica Lodi-Borghetto San Colombarro-Chignolo," has been formed in Italy, with a capital of £20,000, to lay down and work a system of electric tramways between Lodi and various points in the neighbourhood. The necessary apparatus will be furnished by the Brush Company.

Technical Attaches.—The Vienna correspondent of *The Times* states that the Russian Government proposes shortly to appoint technical attachés to its Embassies and principal Legations abroad. Their duty will be to report to the Minister of Public Works on the improvements introduced into the working of railways and telegraphs and on practical scientific discoveries generally.

Newcastle. — According to the *Newcastle Daily Chronicle* arrangements have been arrived at between the Newcastle District Electric Lighting Company and the Newcastle-upon-Tyne Electric Supply Company to supply the electric light in Newcastle in such a way as not to interfere with the interests of each other, each company working by itself within an area mutually agreed upon. Both companies are now actively engaged in laying down their mains.

The St. James's and Pall Mall Company.—In a note in our last issue it was stated that at a meeting of the St. James's Vestry the previous week, a letter was read from the St. James's and Pall Mall Electric Lighting Company, stating that it was their intention to apply for a Provisional Order to construct two electric railways. We have since been informed that the report of the meeting upon which our note was based was incorrect, and that the St. James's and Pall Mall Company have no such intention.

The Electric Light for Manila.—Her Majesty's Consul at Manila, Philippine Islands, reports that the municipality is desirous of obtaining tenders for the lighting of the city and suburbs by electricity, instead of the present system of petroleum lamps. The total distance to be so lighted is about 36 miles, and the time for receiving proposals is limited to a period of six months, dating from the 1st ult. Further details and plans may be seen on application to the Commercial Department of the Foreign Office.

St. Helens.—The Board of Trade having informed the Corporation that it would not consider the withdrawal of its application for electric lighting powers a reason for refusing to grant a future application, the Gas Committee have now recommended the Council to withdraw the application during the present

Digitized by Google

Session. A sub-committee has been appointed to report upon the question of the supply of electricity, and it is expected that some practical scheme will be presented to the Corporation in the course of the next year.

The Institute of Patent Agents.—The first qualifying examination for certificates entitling to admission to the Register of Patent Agents, established under the Act of 1888, was held, November 18th to 23rd, by the Institute of Patent Agents, under the regulations passed by the Institute and approved by the Board of Trade, in accordance with the Register of Patent Agents Rules, 1889. The successful candidates were :—Mr. Thomas Henry Barron, of Huddersfield, and Mr. George Beloe Ellis, of London.

Electric Brake Trials.—Trials have recently been made at Birmingham on the London and North-Western Railway of the electric brake designed by Prof. Forbes and Mr. Illius A. Timmis. An entire train of carriages fitted with it are being constructed by Messrs. Brown, Marshall, and Co., of Adderley Park, for use on a line in Russia. The chief gain of an electric brake is rapidity of action. A train of average length will feel the brake power throughout its length almost instantaneously as against three or four seconds required by the brakes at present in use.

The Royal Society.—Amongst those who were elected to foreign membership of the Royal Society last week was Prof. Rowland, of Baltimore, for his determination in absolute measure of the magnetic susceptibilities of iron, nickel, and cobalt; for his accurate measurements of fundamental physical constants; for the experimental proof of the electro-magnetic effect of electric convection; for the theory and construction of curved diffraction-gratings of very great dispersive power; and for the effectual aid which he has given to the progress of physics in America and other countries.

Birkenhead.—At a special meeting of the Birkenhead Town Council, held on Friday last, the Town Clerk read the provisions of the "Birkenhead Corporation Electric Lighting Provisional Order." Mr. Bloor said it was a dog-in-the-manger policy for the Corporation to apply for a Provisional Order with no binding conditions attached to it, but which was merely intended to keep out companies who were willing to do the work. Alderman Rawcliffe: "It is to keep the power in our own hands that we take these steps, and prevent the streets of the borough being cut up by outsiders." It was finally decided to proceed with the Order.

Aberdeen.—The Gas Committee of the Town Council had under discussion on Friday last the report of the deputation who recently visited several towns in England to inspect the systems of electric lighting in operation. It was resolved to recommend that application should be made for both a Provisional Order and a Bill, the borrowing powers to be £50,000, and the Gas Corporation funds to be the security. It was also decided to divide the area to be applied for under the Order into two districts, to be lighted within two and four years respectively. The cost of providing an installation for the restricted area is estimated at £20,000.

A Smart Performance.—In consequence of the total failure of the Manchester gas supply, the Lancashire and Yorkshire Railway Company decided to light the Victoria Station with the electric light. Within six hours of the time the order was given, the most important platforms were lighted, and the whole station was brilliantly lighted with about 250 incandescent and a few arc lamps within 36 hours. The current had to be conveyed for about a quarter of a mile, and all the necessary circuits had to be run. The whole of the installation was carried out by the Company's telegraph and electric light staff, there being only about ten men on the work. The new light has since been running day and night, and steps are being taken to have the light fixed permanently

Dublin.—At the last meeting of the Town Council the chairman of the Finance Committee moved the adoption of the estimates of amounts to be paid by that committee out of the improvement fund for the year to end December 31, 1890. One of the items was a sum of £1,687. 10s., being the first of the yearly instalments of principal and interest in respect of the account loan of £50,000 for the purpose of supplying electricity for public purposes. After considerable discussion the estimate, reduced by a sum of £324. 1s. 2d., was passed. Alderman Dillon said the delay in the commencement of the works was principally due to the fact that though the licence for public lighting by electricity had been issued long since, the licence for private lighting had not been obtained till a few months ago. They hoped to have a portion of the city lighted by electricity next year.

Proposed Singapore-Borneo Cable.—At the meeting of the British North Borneo Company, on Wednesday, Rear-Admiral R. C. Mayne, C.B., M.P. (the Deputy-Chairman), in reply to a question, stated that negotiations had been pending, the outcome of which would be that, if a small subsidy could be obtained from the British Government, a telegraph cable would be laid from Singapore to Borneo. The proposal had been laid before the Colonial Office, who were in favour of it, but it remained to be seen what the Chancellor of the Exchequer would do. The point that had been urged in favour of the Government helping them was that a line would thus be secured to Hong Kong entirely in connection with British soil. By laying a cable *vid* Borneo, the necessity of going to Saigon in order to get to Hong Kong would be avoided.

Dundee.—A special meeting of the Town Council, Police Commission, and Gas Commission was held, on Friday last, for the purpose of considering the question of electric lighting of the city. The Electric Lighting Committee reported that they had discussed Dr. Hopkinson's report, and had been further advised on the subject by Prof. Ewing. The alternating-current system, with transformers, is, in Dr. Hopkinson's opinion, the best if the gas works are selected for the station. The plant, he thinks, should be able to supply 30,000 watts, or 5,000 lamps of 60 watts each; and he estimates the total cost at £24,726, the annual charges for a plant of 5,000 lights being £5,026 11s. 6d. The corresponding cost upon the three-wire system—the station to be within the area to be supplied—is also fully detailed, the total for conductors and distributing mains being estimated at £19,047, the current charges being estimated at £4,360. After a lengthy discussion, it was decided that in order to maintain the *status quo* and secure the position of the public, a Bill, and also a Provisional Order, should be deposited by the Gas Commissioners and the Police Commissioners to obtain all necessary power, leaving over for after consideration the particular body which should take the power, and that it should be remitted back to the Joint-Committee to collect, mature, and report further information and details.

City and Guilds of London Institute.—On Tuesday night Sir H. Roscoe, M.P., presented the prizes and certificates to the students of the City and Guilds of London Institute at Goldsmiths' Hall, Foster-lane, E.C. There was a large attendance. Amongst those present were the Lord Mayor, who presided, Sir R. Fowler, Sir S. Waterlow, Sir P. Magnus, Sir F. Bramwell, Profs. Ayrton, Gladstone, and Unwin. Mr. W. S. Prideaux (hon. secretary) read a short report on the work of the central institution during the past term. Mr. J. Watney read a report on the work of the Finsbury Technical College, and Prof. Thompson read out the list of awards. Sir H. Roscoe, after distributing the prizes, observed that the Technical Instruction Bill had materially changed the whole aspect of affairs, and sooner or later a complete scheme for technical education would have to be framed. The beginning of such a scheme had been made by the efforts of the City of London Institution, which, with its many branches, was a nucleus of such a system, the importance of which would only be recognised when the history of that important movement came to be written. It was, however, not only necessary to educate the craftsman; his employer needed it equally, if not more. He thought that the Council of the Institute had fully recognised that fact at their central institution. The public should not imagine that the establishment of a larger number of Polytechnics which had recently been founded was the only goal to be aimed at in higher technical instruction. They could not too clearly understand that whatever success attended the foundation of these metropolitan Polytechnics, the work of the centres of higher technical education still remained

Digitized by Google

MAGNETISM IN IRON AND OTHER METALS.*

BY PROF. J. A. EWING, F.R.S.

I.

§ 1. **Introductory.**—In the series of articles of which this is the first, it is intended to give some account of what experiment has taught about the magnetisation of iron and other members of the magnetic family of metals, with special reference to recent work. The subject has advanced so fast and so far during late years that the text-books have scarcely kept pace with it. Thanks to the labours of Stoletow, Rowland, Hopkinson, and many others (for in so wide a field it would be easy to name a long list of workers), our knowledge of the magnetic qualities of iron has been so much extended that it may fairly be said to deserve a text-book to itself. There are probably many students to whom something of this kind would be of service. At present anyone who wishes to gain a little more information than is given in the somewhat meagre notices which the subject receives in current text-books, has no resource but to explore a large number of more or less bulky and inaccessible original memoirs. If the student aims at thorough knowledge, or if his purpose is to trace the matter historically, nothing could be better; but the quest is long and sometimes not a little wearisome. At the same time the practical bearing of the subject, in relation, especially, to the action of dynamos and transformers, forces it upon the attention of many who have not much time or taste for that method of study. The writer hopes that he may meet a want on the part of general students of physics, as well as on that of practical electricians, when he endeavours to set forth the principal results of experiment on the magnetisation of iron in a connected and in an elementary manner, without either undue brevity or excessive detail. To those who have followed what has lately appeared in original Papers on this subject, he does not expect to have anything new to tell.

Before proceeding to speak of experiments and their results, it may be well to recall the various conventions according to which magnetic quantities are expressed. Most of this introductory matter is, of course, familiar to the student, but parts of it are, perhaps, less familiar, and some confusion is apt to be felt on account of the variety of ways which one may follow in stating facts about magnetic quality. The magnetisation of an iron bar, for example, may be specified by its magnetic moment, by its intensity of magnetisation, or by its magnetic induction; and its readiness to be magnetised may be measured either by what is called its magnetic permeability, or by another not quite identical quantity called its magnetic susceptibility. The student is liable to feel that there is an *embarras de richesse* in magnetic ideas and phraseology. The various lights in which the magnetism of a piece and its magnetic quality may be regarded are, of course, consistent with one another, and are related in a simple enough manner. Some forms of expression have the advantage that they fit in best with modern conceptions of the magnetic state; others survive because they are more convenient in special cases. The magnetic circuit of a dynamo is most simply treated by using one set of terms; another set of terms come readier to hand when we have to speak about the properties of a magnetised steel bar. The student will, therefore, do well to master the meaning of all the magnetic terms in common use, and should accustom himself to look at magnetic phenomena from various points of view.

§ 2. **Magnetic Poles, Axis, and Moment.**—An old and still useful way of looking at the matter is to think of the action of a magnet as due to the existence of two quantities of hypothetical magnetic substance, or "free magnetism," equal in amount and opposite in kind, which are distributed in the neighbourhood of the two ends. These hypothetical positive and negative substances have the property that two portions of like kind repel each other, and two portions of unlike kind attract each other, with a force which is proportional to the product of the amounts of the portions, and inversely proportional to the square of the distance between them. In an ordinary bar magnet the free magnetism is distributed partly over the surface at and near the ends of the bar, and partly throughout the interior of the bar, especially near the ends. The action of the magnet upon anything at a considerable distance from it will be much the same as if the free magnetism were concentrated at two points, near the ends, which are called the *poles*. Strictly speaking, there are no precise poles in a magnet—that is to say, there are no two points at which we might imagine the positive and negative free magnetism to be gathered, and find the magnetic action in external things to be quite unchanged. It is only when the bar is very thin and uniformly magnetised (§ 7, below) that we come near to realising the idea of two definite centres of force at the ends of the bar where the positive and negative free magnetism is concentrated. The idea of poles in a magnet has therefore to be employed with much caution, but it is too useful to be altogether abandoned.

The *strength* of a pole is the whole amount of magnetism which is to be taken as gathered there. *Unit pole*, or unit quantity of free magnetism, is that quantity which repels or attracts another quantity equal to itself with unit force when the two are placed at unit distance from each other. It is now a universal practice to express magnetic quantities in terms of the centimetre-gramme-second system of units. We may, therefore, define the unit pole as that which acts on another pole of equal strength with a force of one dyne when the two are placed one centimetre apart. The *axis* of a magnet is the line joining its poles. The *moment* of a magnet is its pole-strength multiplied by the distance between the poles. According to this conception of a magnet, the magnetic action of the bar is due to the free magnetism at the poles; the middle portion of it is neutral, and merely serves to hold apart the ends, in which the free magnetism resides.

§ 3. **Magnetic Field and Magnetic Force.**—For many purposes this conception is a very serviceable one. It is especially

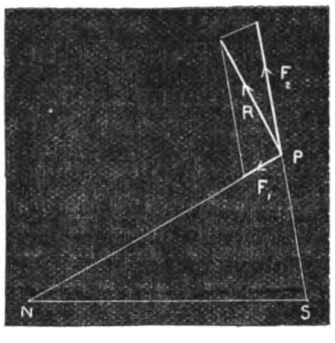


FIG. 1

serviceable when we have to treat of the influence which the magnet exerts throughout the space in its neighbourhood, or throughout what is called the *magnetic field*. To examine the magnetic field, we may think of the force which the magnet N S (Fig. 1) will exert on an imaginary particle of magnetic substance, P, placed anywhere in its neighbourhood. The two poles of the magnet will exert two forces, F_1 and F_2, which are proportional to $\frac{1}{(N P)^2}$ and $\frac{1}{(S P)^2}$: one pole will tend to pull the particle towards it, the other pole will tend to push the particle from it. These forces will have for their resultant a single force, R, which is the whole force exerted by the magnet upon the particle. The direction of this resultant is definite at any point in the field, but its amount will depend on the amount of magnetic substance in the particle. Suppose, now, that we take a particle in which the amount of magnetic substance is one unit (as defined in § 2), and observe the force exerted upon it when it is placed anywhere in the field, we now find a force definite (at any one point of the field) both in magnitude and direction. This force measures the intensity of the field at the point in question, and is called the *magnetic force* at that point. Instead of one magnet only there may be any number of magnets, the poles of which contribute to the production of magnetic force at any point of the

*All rights are reserved.

Digitized by Google

field in which the magnets lie. We may still think of each pole as exerting its own component of force on the imaginary particle of unit strength, and then combine all these components to find a single resultant which measures the magnetic force.

Electric currents also give rise to magnetic force in their neighbourhood, so that, in considering the value of the magnetic force at any place, we have to take their action into account as well as the action of the poles of neighbouring magnets. But whatever current or magnets contribute to the production of the magnetic field, the magnetic force at any point of space has a definite direction and value, which may be expressed by stating the mechanical force which would be felt by a unit magnetic pole when placed there. The direction of the magnetic force is the direction in which the unit particle

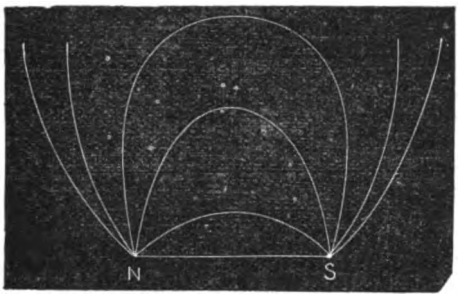


Fig. 2.

will tend to move, and the value of the magnetic force is the value in dynes of the mechanical force which tends to move the particle.

§ 4. **Lines of Magnetic Force.**—If we allow the particle to move so that the direction it takes is, at every instant, the direction in which the magnetic force acts upon it, and if we mark the course it takes through space, we shall trace out what is called a *line of magnetic force*. In general these lines are curved, for the direction of the magnetic force varies as we pass from point to point through the field. If the magnetic field is produced by a single pair of opposite poles, the lines of force start from the south pole and spread in curves, which bend round through space, and all

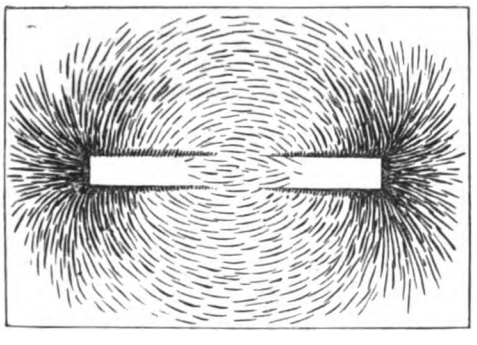


Fig. 3.

converge on the north pole (Fig. 2). The well-known curves in which iron filings group themselves when scattered near a magnet represent approximately the forms taken by the lines of force. In the field produced by an actual bar magnet (Fig. 3) the lines do not converge as in Fig. 2 to a single pair of points, for the positive and negative quantities of free magnetism are each distributed over a considerable part of the length of the bar. Where the lines come close to one another the magnetic force is intense: where they lie far apart the field is weak. If we pass along lines of force from one place to another in the magnetic field, we shall find that the intensity of magnetic force at each place is proportional to the number of lines of force which cross an imaginary surface of unit area, placed there and set so that it stands at right angles to the direction of the lines. We can make the number of lines which cut such a surface not only proportional, but numerically equal to the magnetic force throughout the whole field, by adhering to a proper convention as to the whole number of lines to be drawn. The convention is that the number of lines of force which start from any pole of strength m is $4\pi m$. Consider a sphere of radius r in centimetres enclosing a magnetic pole of strength m. According to the convention, the number of lines of force which radiate from the pole and cut the surface of the sphere is $4\pi m$. But the area of surface of the sphere is in square centimetres $4\pi r^2$. The number of lines of force per square centimetre at the surface of the sphere is therefore $\frac{4\pi m}{4\pi r^2}$, or $\frac{m}{r^2}$, and this is also the measure of the magnetic force there, for the force is due to a pole m at a distance r.

§ 5. **Uniform Magnetic Field.**—In a uniform field—that is to say, a field in which the magnetic force has the same direction and the same intensity at all points—the lines of force are straight, parallel, and equally spaced. The magnetic field due to the earth's action as a magnet is sensibly uniform throughout any small space, such as that of a room. Good approximations to a uniform field can be obtained by suitable arrangements of magnets, or of conductors carrying electric currents. Thus, if we take a long uniform solenoid or helix of wire, wound so that the diameter is constant and the number of turns is the same in each unit of the length, and pass a current through it, a magnetic field will be produced which is very nearly uniform throughout the whole space within the solenoid, except close to the ends. The value of the magnetic force in this field due to the current is $4\pi C n$, where C is the current in absolute electro-magnetic units, and n is the number of turns in the winding per centimetre of the length of the solenoid. Reducing this to practical units, the magnetic force within the solenoid is 1·257 times the number of ampere-turns per centimetre of the length.

Again, a nearly uniform field may be produced by taking two similar magnets with flat ends and placing them in line with their flat ends parallel, so that the north pole of one nearly touches the south pole of the other. In the narrow gap between the ends facing one another there is a strong magnetic field, through which the lines of force pass straight across from one face to the other. The field is very nearly uniform except at the edges.

(To be continued.)

THE KEELEY SYSTEM OF WORKING TELEGRAPH CIRCUITS.

We have recently had brought to our notice a system of working telegraph circuits, devised by Mr. D. H. Keeley, of Ottawa, which is claimed to be an improvement on existing methods; and, as the matter is one of importance, especially to those concerned with the working of submarine cables, we give below a description of the arrangement proposed.

After setting forth the effects of static charge and discharge, due to the electrification of the conductor, on the transmission of signals in a telegraph circuit, the inventor states that his object is to remove this impediment, and to render the transmission of signals, both in single and duplex circuits, on aërial or submarine wires of the greatest length, practicable at the highest rate of speeds. This he claims to accomplish by the simple expedient of applying a rapidly reversing current at the receiving end of a line worked by a double-current transmitter and using polarised receiving instruments. When the sending-key is depressed, a current of one polarity, say +, goes to line. If the current-reverser at the distant end presents a − current to line, that current combines its effect with that of the − current transmitted and affects the polarised relay in one direction, say closes it. When, however, the current-reverser presents a + current to line, its effect is neutralised by that of the + current transmitted, and the receiver remains closed. If the key at the sending station is upraised, a − current is transmitted and combines with the current presented to line by the

Digitized by Google

current-reverser; should it be +, moving the polarised receiver in the direction opposite to its movement before, and opening it. Should the current at the receiving end, however, be −, it is neutralised by the − transmitted, and the receiver remains open. Hence the distant receiver is actuated by the distant battery under the operation of the sending key.

The annexed figure shows the application of the system to cable circuits worked by double key, where signals are effected by right and left deflections of a galvanometer needle produced by current impulses of dot length uniformly, + representing dots and − dashes. The object sought is to obviate the increased charge of the cable which would attend the longer depression of the key in signalling a dash on the Morse system. In order to effect a partial neutralisation of the residual current which gradually discharges from the cable after the signalling current is withdrawn, the receiving instruments have hitherto been placed, through the medium of a condenser, in circuits secondary to those in which the transmitters operate. This arrangement involves the introduction of great resistance between the cable and the earth at one end of the circuit, preventing the rapid discharge of the cable, causing a sluggish movement of the receiving instrument, and hindering rapid signalling. It is well known that the effect of the residual current can be partially neutralised by the presentation of a reverse current to line at the transmitting end, immediately on the withdrawal of the signalling impulse; and the diagram shows how this result, which has not hitherto in practice been efficiently attained, is sought to be secured under Mr. Keeley's system. The condenser and secondary circuit are dispensed with, and the double-current keys arranged to transmit automatically the alternate impulse in their movement from the under to the upper contact, after the signalling impulse has been sent into the cable.

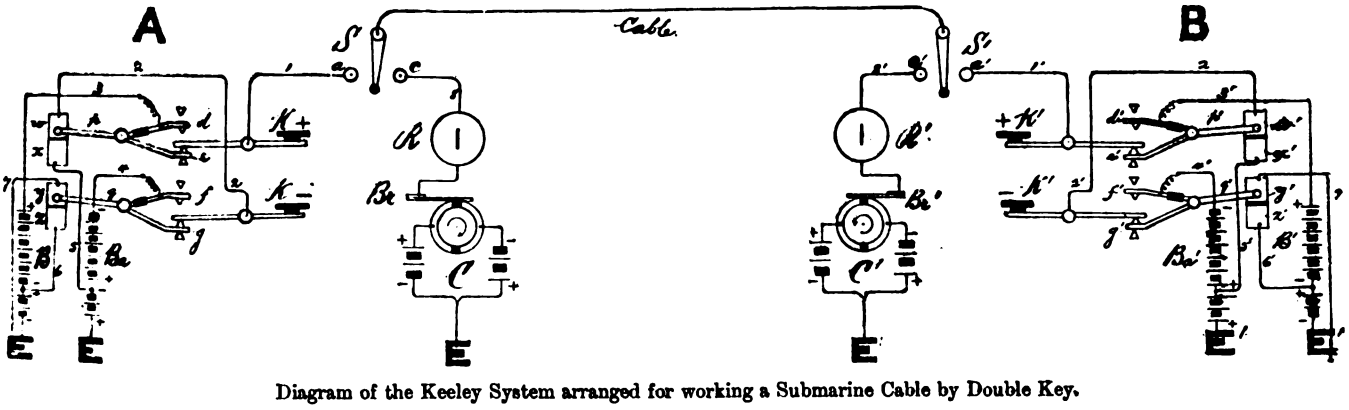


Diagram of the Keeley System arranged for working a Submarine Cable by Double Key.

In the figure S at station A is a three-point switch, to the arm of which the cable conductor is directly connected. When S is on the point *a* the cable is connected with the transmitting keys, and when S is on the point C the cable is connected with the receiving instrument. The keys K + and K − when depressed send currents from the batteries B and B *a* respectively. The key K + plays between jaws *d e*, from whose arbor a spring extension, *p*, presses against flat contact plates, W *x*; the friction contact thus created holds the jaws *d e* in whatever position moved by the rear arm of the key; the contact on the jaw *d* is insulated from the jaw *e* and extension *p*; the jaw *e*, and extension *p* are in electrical continuity. The key K − is likewise associated with jaws, *f g*, extension, *q*, and contact plates, *y z*. R' is the receiving galvanometer or syphon recorder whose deflections to right and left represent dots and dashes. C is the commutator or current alternator already described. The arrangements at station B are precisely similar, and the parts are correspondingly lettered.

Suppose the switch S at station A is put on the point *a* and the switch S' at B is put on the point *c'*, then A will be in position to send to B; and, in the normal condition, both keys being upraised at A, the circuit will be from E at A, by wire 7, plate *y*, extension *q*, jaw *g*, key K −, wire 2, plate *w*, extension *p*, jaw *e*, key K +, wire 1, point *a*, arm S, to cable, thence by switch S', at B, point *c'*, wire 8, through receiver K', brush B *r'*, alternator C', to earth at E. There is in this case no battery in circuit at the sending station A, while at the receiving end B the commutator C' is alternately presenting + and − currents to line through the receiver K'. These currents, rapidly succeeding one another, have the effect of oscillating the recording needle of the receiver K' within narrow limits.

Now if the key K + at station A is depressed, the following action occurs. The rear arm of K + leaves the jaw *e*, and striking the jaw *d*, moves it to its limiting stop. By this movement the extension *p* is shifted from the plate *w* to *x*. While the key K + is in contact with jaw *d*, the + current from the battery B goes to line, the circuit is from E to B −, from B + by wire 3 to jaw *d*, key K + to line, thence through the receiver R' at station B, alternator C', to earth at E. The + current now proceeding from A, combines with the − from the alternator C' at B, and deflects the recording needle to one side, say the right, signalising a dot. The + current from A opposes the + from the alternator C' at B; hence this latter current is neutralised in its normal effect in the receiving instrument. Meanwhile, the key K + at station A is upraised, the rear arm leaves the jaw *d*, withdrawing the + current from the line, and passes down towards the jaw *e*; a discharge from the line follows. The part that goes to earth at station B is opposed and neutralised by the first + current emanating from the commutator C' at that end; this neutralisation of the discharge is further facilitated by the transmission of a momentary reverse current from the distant end, as will presently be explained, and the needle of the receiver promptly returns to its normal limit of oscillation. Meanwhile, the rear arm of the key K + at station A strikes the jaw *e*, and moves it down to its limiting stop; during this operation, however, a − current is momentarily presented to line. When the rear arm of K + touches the jaw *e*, the extension *p* is still on the plate *x*, which is connected to a point low down in the series of the battery B *a* −. In this condition the circuit is traced from E through part of battery B *a* + by wire 5, to plate *x*, extension *p*, jaw *e*, key K +, to line. A weak − current is, therefore, presented to line; it is, however, only momentary—the movement of the rear arm of K + carries the jaw *e* down to its limiting stop, and shifts the extension *p* from the plate *x* to *w*, whence the circuit is traced, as in the normal condition, to earth.

It will be seen by the drawing that the key K − is in the same way connected with the batteries B *a* − and B +, so that the depression of K − sends the full current of B *a* − to line; and when it rises, a weaker current, emanating from a portion of B +, is sent to line. The object of this device, as already explained, is the presentation of the weak alternate current, which, combining with the return current following the withdrawal of the previous signalling one, contributes to the neutralisation of the discharge from the distant end, as it occasions a concurrent flow of electricity in the opposite direction in the circuit. The consequence is that the movements of the recording needle to the right and left at the distant end can be more rapidly produced and more sharply defined for each successive signal than has been possible with the circuit arrangements and devices heretofore employed in double-key transmission.

Mr. Keeley's system is a very ingenious attempt to improve

Digitized by Google

the working of submarine cables, but we do not think it will be found to contain the elements of practical success. Although, as a whole, it has never, so far as we know, been tested before, some of the arrangements have been tried in various ways without offering any advantage, or, indeed, being equal to the present methods of signalling. It would seem that Mr. Keeley has not had practical experience of the working of long submarine lines, or he would have known, for instance, that it is out of the question to use polarised relays. A feature is made of the claim that the arrangement described would do away with the necessity for condensers, but, as a matter of fact, they are found to render the signals more distinct and reduce the effects of earth currents to a minimum, and are used at both ends of the line.

Inventors seem frequently to assume that retardation on submarine cables can be overcome, but it is no more likely to be entirely eliminated than friction or gravity. We happen to know that a system similar to Mr. Keeley's in other respects—of sending rapid reversals through a cable from the transmitting end—has been quite recently tried, but with an entire absence of success.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

"Electrical Engineering in America."*

BY G. L. ADDENBROOKE, ASSOCIATE.

(*Concluded from page 149.*)

CENTRAL STATIONS.

The next station I visited was that of the Westinghouse Company, at Pittsburg. It is situated in a large building of the warehouse type, quite in the centre of the town. The boilers here are of the water-tube type, but heated by natural gas instead of coal. This natural gas is brought in pipes to the town from a distance of 35 miles. The company who own the line of piping—of which, by the way, Mr. George Westinghouse is also President—sell this gas to manufactories, &c., at a rate which is nearly equivalent to the cost of coal; so that, although the convenience is great in using it, the economy is not so large as might at first be anticipated. Work at the Pittsburg station was in the first instance begun with two Corliss single-cylinder engines of the ordinary type, driving on to a line of countershafting; but this method of working has not been extended, and one of these engines has since been removed. The next additions to the station consisted of Westinghouse Standard engines of 250 indicated horse-power, driving 2,500-light alternating dynamos. These engines stand on square blocks of concrete or masonry; the blocks for this size engine are about 7ft. by 5ft. The last additions are of the new type of Westinghouse Compound engine. From a power point of view, as well as from an electric lighting point of view, the station has therefore something of historical interest.

While in Pittsburg I had an opportunity of going carefully through the Westinghouse engine factory with Mr. Ralph Bagaley, the vice-president and manager, and of seeing all the details of construction of each of the different types of engines. The Westinghouse Company make three styles of engine, each worked by a piston valve and single eccentric. The Standard type is so well known that I will not say anything about it. In it, as you are probably aware, the steam valve is between the cylinders, and set at a slight angle to them, while the cylinders are set rather over their work, and not directly in a vertical line above the crank shaft. The Junior and the new Compound engines are on somewhat different lines to the Standard, while the main principles involved are nearly the same. In these two later types the piston valve lies horizontally along the top of the cylinder heads. It is operated by a single eccentric working outside the engine case in a vertical direction, the motion being changed to a horizontal one by means of an L piece attached to the engine case by a hinge. The whole movement is of simple character, and works exceedingly well. In fact, there are practically no more working parts in the Compound engine than in the Junior or the Standard two-cylinder patterns, and the one is as simple as the other. The Standard type has now stood the test of several years' work very satisfactorily, and there is no room to doubt that the compound engine, constructed in the same shops and by the same method as the Standard engine, will wear at least as well. The makers' tests show exceedingly good results for this compound engine, viz., from 18½lb. to 19½lb. of water per brake horse-power hour with condenser, and from 24lb. to 25½lb. without condenser. I saw the testing apparatus in the makers' shops, and engines undergoing their test preparatory to delivery, and feel perfectly confident that the figures given by the makers are thoroughly reliable. I will not describe this engine more fully, although to do so would probably elicit an interesting discussion, as it would be wandering from the subject of my Paper. On the other hand, the remarks I have made are not intended to compare the Westinghouse compound engine with any other engine of at all similar type, but rather to draw the attention of electrical engineers to the fact that there are now, at any rate, two large firms of the highest repute turning out this class of engine, and ready to guarantee economy and efficiency on a par with Corliss engines.

Returning to the Pittsburg station, five Westinghouse engines of 250 indicated horse-power drive five alternating-current dynamos of 2,500 16 candle-power lights capacity each, besides the machine driven from the Corliss engine. The exciters are run from smaller engines. The engines driving the alternating dynamos make 250 revolutions per minute, the dynamos making 1,050 revolutions per minute. The power is conveyed overhead by belts to the first floor, where the dynamos are placed. Each of these dynamos is on a sliding bed, so that the belt can be tightened, and, as I have already said, the exciters are run separately from the machines. The machines are so well known it is hardly necessary to describe them. I may, however, perhaps with advantage say a few words on the construction of the armature, which is the least easy part to understand from written descriptions or diagrams. In Prof. Silvanus Thompson's book on dynamo machines the diameter of the armature is given at nearly twice its breadth. While this is true of the smaller machines, in the 2,500 machine—which is the standard size for large stations, and is the size employed in the new station in Sardinia-street, in London—the length of the drum is considerably greater than the diameter. The drum itself is formed of thin iron plates, just like an Edison armature, only of larger diameter; and as the iron near the centre is useless, holes are punched in the sheets, which lightens the armature and secures ventilation. Round the outside of this iron core, and over the two ends, insulation is laid. As regards the coils of wire in which the current is generated, they are made in this way:—Beginning at the inner side of the coil, the wire is wound on an oblong frame to correspond with the shape of the field-magnets, one turn on the top of the other. The coils are only one wire thick—that is, there is only one layer of wire between the drum and the field-magnets. When these thin flat coils are laid on the drum, the round ends of the coils are turned down at right angles over the edge at each end of the drum, and the connections from coil to coil are made. A small piece of wood screwed into the side of the drum, and projecting over the end of each coil, keeps it in its place. When all the coils are fixed in their places, sheets of mica are laid over them all round the armature, and bands of fine wire with a little thicker insulation underneath them are bound round the whole armature at short intervals, in exactly the same way as is usual with the armatures of continuous-current machines. An armature made in this way has perhaps rather an amateurish look about it, but there is no doubt that they work well in practice and give excellent results. It is further worth noting that as the field-magnets are long and narrow—a ratio of at least 10 to 1 in the large machines—they cannot be very economical as far as exciting current is concerned. Still, since the exciting current, anyhow, bears such a small ratio to the energy which the machine will transform into electric current, this is not a very material point. The mains are run from the dynamos to the switch-board in troughs cut in the joists supporting the floor, which is made to take up over these troughs. The switch-board at Pittsburg consisted of a wooden frame boarded over, about 9ft. high and 12 or 14ft. long, and standing about 3ft. from the wall, so as to give room to go behind and make the connections. This, I may say, is the usual way of arranging switch-boards in America.

The general type of switch used in America for alternating-current work—and it is not confined to the Westinghouse Company—is exceedingly simple in construction and operation, as well as efficient. In general principle it is like an ordinary tobacco chopper. To the top of a small upright a lever is hinged, terminating in an insulated handle. The metal part of this lever has a hatchet-shaped projection cast on it, projecting in the same plane as the motion of the lever. When the lever is pulled down the hatchet-shaped piece sticks in between two spring pieces set up to receive it, and so makes contact. If the lever has two hatchet-shaped pieces attached to it opposite each other, and engaging in spring pieces on either side, according as the handle is thrown over in one direction or the other, we have a two-way switch. Unite two of these levers together by a cross-bar of insulating material, with a handle in the middle, and we have a double-pole two-way switch. Place a spring in the columns holding the hinges on which the levers turn, to throw down the levers when nearing the spring contact-pieces on either side, and we have the complete article.

* Paper read before the Institution of Electrical Engineers, November 28, 1889.

Digitized by Google

These switches were all mounted on wooden bases. In fact, I saw no slate used in America anywhere for such purposes, except at the Electric Club in New York. In the new Westinghouse Station in Sardinia-street, however, the whole of the switches are mounted on enamelled slate, and very nice they look.

One exciter is used for several machines; each exciter has a resistance in its field-magnets, which can be varied. There is, moreover, a separate resistance in the field-magnet circuit of each alternating machine, so that the E.M.F. of the machine can be varied while its speed remains constant. Double throw-over switches are connected so that each alternating-current machine can be connected to either of two exciters, and so that any main circuit can be run from any machine. The general principle followed is to keep the machines at work as fully loaded as possible. Thus in the day many circuits will be run off one machine, but as evening comes on they will one by one be taken off and put on other machines. The throwing over is so quickly done as to only just cause a perceptible flicker in the lights. All these switches were bare and unprotected. I did not hear or see much of the method of running two separate machines parallel on the same circuit. Whatever may be done in isolated instances, it does not appear to be practised generally; indeed, with the American system of running a number of small circuits instead of fewer heavy ones, the desirability of doing so does not often come in.

I should like to endorse here what I see Professor George Forbes said in his Paper on foreign central stations with regard to feeders. The area which can be economically supplied from a central station has certainly been greatly increased by the adoption of 1,000 or 2,000 volts instead of 100. But at the same time our notions of the area which can be supplied from one centre have experienced a corresponding growth. If, then, such an increased area is supplied on a high-tension system from one centre, we have as great, or nearly as great, falls of potential to deal with as if the low-tension system were used over a correspondingly smaller area. To secure the highest class of lighting, therefore, together with the flexibility desirable in an installation lighting a large area, the whole of the outside work should be based on as complete and carefully designed a set of feeders as from our present knowledge we should employ with a low-tension system. On many of the Westinghouse feeders lighting at great distances, there is a fall of potential of as much as 10 per cent. To avoid pilot wires an indicator is used, which, I think, Professor Forbes has already described here. There is no regular voltmeter for driving the machines by, but an indicator is used with but one single mark on the dial. When the machine is giving the voltage which is required at the further end of the feeder to keep the lamps at their proper brightness, the hand of the indicator will be right over the mark on the dial. The loss in the feeder will, of course, differ according to the current flowing through it, so, to allow for this, a compensator is attached to the indicator. The main current flows through the compensator, which is arranged to cause a slight back-pull on the needle of the indicator: this pull becomes greater as the current increases. As the current increases, therefore, a slightly higher voltage on the machine will be necessary to keep the needle in its place. The instruments have, of course, to be made so that they can be adjusted to the calculated requirements of each feeder. When once set right, however, their operation is simple enough. The Westinghouse Company also use a piece of apparatus containing an adjustable converter, which enables them to supply current from the same machine to two feeders having a different fall of potential.

The Thomson-Houston Station in New York is situated in Twenty-fourth-street East, near the river, and occupies what was formerly a large sugar refinery. It is, therefore, a building of the warehouse class, but very strongly built. I was told that this station was neither so large nor so well-arranged as their station in Brooklyn, but the latter, I regret, I had not time to see. Two boilers struck me here as out of the ordinary patterns. The simplest way to describe them is, I think, to consider them as large locomotive fire-tube boilers set on end. The tubes are about 15 feet long, and the water-line is about 10 feet up the tubes. This gives a considerable steam space above, through which the fire tubes pass, superheating the steam generated, and thoroughly drying it. At first sight one might suppose this an uneconomical pattern, as the heated gases pass so quickly into the flue. But the gases appear to give out their heat well, for Mr. Foster, the station superintendent, told me the temperature of the gases going into the flue was not above 550 degrees Fahr. The lower portion of this boiler is, however, the interesting part. I cannot very well describe it without the aid of a diagram. The outer shell of the boiler is expanded out and prolonged about a couple of feet below the tubes. It is turned up at the bottom, and united all round to the crown plate of the boiler, into which the lower ends of the tubes are expanded. This prolongation of the shell then forms a circular hollow, or chamber, about 2ft. deep. The internal space enclosed by this hollow chamber forms the fire-box or furnace, and is about 6ft. in diameter. Any sediment collects in the hollow chamber, and can be taken out at manholes. There were two of these boilers in use, and it was in contemplation to increase their number. The engine—and there is only one—which furnishes power to this station is a large compound condensing Corliss engine; the two cylinders being in tandem. It is a very fine piece of work of its class. It drives on to a large fly-wheel with a smooth face of about 60in. breadth. This fly-wheel transmits its power to a line of countershafting, which is arranged on the floor above, by means of a large leather belt 58in. broad, and of great thickness. I think, in all, 17 machines are run from this line of countershafting—15 55-light arc machines and 2 alternating-current machines; in this case the machines are on the same floor as the countershafting. The general construction of the Thomson-Houston alternating-current machines is on the same lines as those of the Westinghouse Company. The main difference is that instead of the ends of the coils on the armatures being turned over the edge of the core, as in the Westinghouse machine, the armature has a sort of prolonged lip all round the outside at each end, and the ends of the coils lie flat on this instead of being turned over. To their smaller machines, also, the Thomson-Houston Company frequently add a commutator, and commute part of the current to excite the field-magnets, as Messrs. Zipernowski, Deri, and Blathy are in the habit of doing. The switch-board here is on much the same lines as I have already described. It was all quite open and exposed; but I was told that, in view of an accident which had happened there a short time before, they proposed to cover the exposed parts up. This way of leaving the working parts of high-tension alternating-current switch-boards exposed is not confined to American manufacturers: a good deal of the Continental work is even worse. Yet all the different patterns of switches and converters could be protected at a moderate cost, and by the exercise of a very moderate amount of skill and ingenuity. I cannot help thinking that not to do so, to save money in this direction, is false economy.

Isolated Plants.

Let us now turn for a few moments from central stations to what are called "private installations" in this country and "isolated plants" in America. I have already spoken of internal construction work, or wiring and fittings, in connection with central stations. With isolated plants there is not much difference. Of course the character of the work differs greatly in different places, as it does here; but, taking it as a whole, I don't think it is equal to our standard, whether from an engineering or artistic point of view. I noticed, by the way, that there is a much greater tendency to turn incandescent lamps upwards in fittings, like gas jets, instead of downwards, as with us the majority of lamps are turned. Isolated plants are driven by steam and gas engines, located in cellars and basements, exactly like they are here. As you are aware, accumulators are not so generally used: I only saw the set at the New York Electric Club. With respect to dynamos, the Americans have been fully alive to the developments, both theoretical and practical, in our knowledge of the magnetic circuit which have taken place during the last four or five years, and all their modern machines appeared to me fairly up to date in this particular. What I may be permitted to call the Edison-Hopkinson type, the Kapp type, the Manchester type, and the Weston type—the latter with two magnets, placed horizontally—appear to be the favourites, just as they are here. The construction and workmanship of the machines appeared to be much on a par with our own: there is little to choose between in one or the other. As to the way the installations are run, judging by that crucial practical test the look of the commutator and brushes, it is much the same as here: certainly, I think, on the whole, not better. The lamps, as a rule, I did not find any steadier, nor are they kept nearer their proper voltage than they are here. This applies to arc lamps as well as incandescent. There is no magic about arc lamps over on the other side of the water: they are subject to the same vicissitudes and uncertainties as they are here, and do not burn steadier than those in any moderate-sized station here where the appliances are such that the lamps get a fair chance. The switch-boards in these private installations are nearly always mounted on wood, and there is even a disposition to cut things fine in the strength and solidity of these wooden base-boards, somewhat, as it seemed to me in one or two instances, at the expense of efficiency and lasting qualities.

Electrical Tramways.

Such very full accounts have been published of everything that has been done in this direction, that there is really little I can add to them. In the *Electrical World* for October 19th there is published a table of the electrical tramways in actual operation *and under contract* in the United States. The total mileage of both is 1,260 miles, with 1,884 cars, on 179 roads. Of this 716 miles were, it appears, actually being operated by electricity at the date of the return, and 544 miles were under contract. Of this total 21 miles were worked by cars with storage batteries, and all the rest, with

Digitized by Google

the exception of two or three miles, by overhead conductors. Nothing can be simpler than the way these overhead conductors are put up. Two lines of posts, about 20ft. high, are set up opposite each other, one on each side of the street; light steel wires are run across from one to the other; a small iron holding-piece is attached to the centre of the steel suspender, and this holding-piece carries a bare hard-drawn copper wire, along which the current flows, returning by the rails. Where feeders are used they run along one side of the street, and connections are made at intervals with the central wire. The way the conductor is carried round corners is on a par with the rest of the work. Posts are set at the further corners of the street, and from each of these two, three, or four steel wires are run at an angle with each other, meeting corresponding wires run from posts on the inner side of the curve. In this way the wire is made to take the form of part of a rough polygon, while the horizontal and vertical movements of the fishing-rod connector on the car are sufficiently ample to keep the contact wheel on the wire when the car is going round a corner. This method of erection does not look very nice, certainly, but it appears to answer the purpose well. Such work could, I think, be more solidly carried out here for about £70 a mile. In a few places standards with projecting arms placed in the centre of the street have been used for carrying the overhead conductor. If neatly constructed, there is no reason why these should be unsightly, and they can be used for the further purpose of lighting the streets. A great point about these electrical tramcars is the way in which their speed can be varied. They can be run at three or four miles an hour in crowded streets and while turning corners; or in broad roads in suburbs where there is not much carriage traffic the pace can be increased to 16 miles an hour. The cars are stopped very quickly and reversed, and will, of course, run either way on the same track. The companies claim a reduction of 50 per cent. in the cost of working over the employment of horses, putting aside all the extra facilities which the electrically-propelled car gives. A very noticeable point about all electrically-propelled cars is the quiet and gradual manner in which they start and come to rest, and the evenness of their motion while running. In these points they greatly surpass both cables and horses. I took the opportunity of talking with a good many members of the general public in the train and hotels about the working of these cars. There is no doubt that the outside public thoroughly appreciate them and understand their value. At present electrical tramway work is the most "live" branch of the electrical industry in the States, and everyone connected with it was full of buoyancy and hope as to its future prospects. It is really sad to think that, after all the skill and care which has been lavished on electrical tramway work here, it should be dragging along in such a half-hearted and pottering fashion.

While in America, through the kindness of Mr. Lockwood I had an opportunity of going over the telephone exchange system of New York with him, and of seeing the Courtland-street Exchange, which contains more than 3,500 subscribers, and is capable of extension to double that number. I also visited the Western Electric Company's factories both in Chicago and New York, where all the telephonic apparatus for use in the States is made. Although a description of the present state of this industry would properly come under the heading of my Paper, seeing that the Paper has already extended to such length, and that, owing to circumstances, telephony is a matter of comparatively limited interest here, however important in itself, I will not say more about it, but will conclude with a few general remarks.

In the early portion of this Paper I endeavoured to convey an idea of the roughness and crudeness of American outside construction work. After reading over the proofs of the Paper, I do not think I have overdrawn the picture: rather, it is underdrawn, if anything. At the same time, I do not wish it in any way to be understood that American engineers are necessarily rough and untidy in their ideas, and incapable of different work. Besides their electrical plant, the numbers of beautiful tools, crowned by the latest pattern of the phonograph, which came over here from America, point to an entirely different conclusion. In accuracy of workmanship and careful finish, when they consider it suits their purpose, the Americans are our equals, if not our superiors: the difference lies in the fact that our ideas often differ from theirs as to where this accuracy and careful finish should come in. English engineering would hardly dare to appear before its fellow-citizens as the responsible owner and designer of such a terrible eyesore as American outside work is; but the American engineer appears to look at it from a different point of view. It is not his business to think of his fellow-citizens. Each of his fellow-citizens, he considers, is quite competent and capable of taking care of himself. It is the business of the electrical engineer to forward and extend the applications of electricity. If in doing this he does anything disagreeable to his fellow-citizens, it is for them to protest when it becomes intolerable to them, not for him to think of it beforehand. And I would like you to try and think for yourselves, and really feel, the enormous facilities which American engineers have in the past enjoyed, and still enjoy, in extending their business, by simply being allowed to erect open wires everywhere through the streets. Even where wires are now being put underground, they are largely put underground in order to carry on existing work, and to extend it, not merely to take advantage later of what may chance to turn up on the route. Besides this, we have all had it drilled into us by this time that it does not matter how perfect, how desirable, how useful a thing is likely to be, before it can come into general use the public have got to be educated up to it, to see it, and feel its desirability and utility, and its practicability—to understand it each man for himself. Now the American system of overhead wires and cheap line construction, bad as it may be in itself, has from the very first brought electricity home to everybody, right to their very doors, not so much as a luxury, but as a practical desirable factor of everyday life, an attraction to public resorts, and a good advertisement for business. Consequently electricity is in America no more a wonder, but a fact of everyday life to an extent that it is not yet here. Looking at their plant, looking at their apparatus, and looking at the facilities which Americans have enjoyed for extended practical experiments on a large scale, it does not appear to me that their actual achievements, simply from an engineering and scientific point of view, have been greater than ours have, in spite of the apathy on the part of the public and investors with which we have had to contend. Still, the fact remains that they have done more business than we have, even considering the difference in population.

Of what work we have done so far, Englishmen may feel justly proud, and with better times I trust we may still be able in friendly rivalry to show that we are competitors worthy of America's best mettle.

DISCUSSION

The PRESIDENT, in inviting discussion, remarked that a Paper of such interest could not be adequately dealt with in the time then at their disposal, and announced that the discussion would be continued at the next meeting on December 12th.

Prof. FORBES admired the realistic description of electrical work in the United States given in the Paper, and fully endorsed the author's account of American electrical engineering, particularly as regards the rough-and-ready way in which the work was usually carried out. Although this class of work might be necessary for the rapid extension of electric lighting (as well as of railways) in America, where great distances have to be covered, yet he thought the more solid construction adopted by English engineers would prove better in the long run. For some time past he had frequently heard of great advances made on the other side of the Atlantic, and expected to have heard something definite about them from Mr. Addenbrooke, but, with the exception of electric tramways, little change seemed to have been made since his visit two years ago. At that time, however, most tramways were worked by accumulators. Information about motors and meters would have been very acceptable, particularly for alternating-current work. Speaking of American factories, Prof. Forbes said that great attention was paid to testing, and, as a result, the efficiency of converters had been considerably increased. As regards distribution, he was glad to hear of the frequent use of feeders, and hoped they would be more generally adopted in England. In conclusion, he asked what kind of cable was used for underground work.

Mr. H. C. DONOVAN considered that the apparent disregard of insulation was to be attributed to the dryness of the climate, and expected to have seen this brought out in the Paper.

Mr. W. P. GRANVILLE said the usual method of specifying insulation resistance of cables (viz., in *megohms per mile*) was unsatisfactory, and that the diameter of the conductor should be taken into account; for if this were not done, the same material, used on conductors of different sizes, would give quite different insulation resistances. He also thought that the insulation tests of lead-covered cable should be made before sheathing, and whilst the cable was immersed in water. In his opinion the whole subject required reconsideration.

Prof. S. P. THOMPSON had hoped to hear that in the five years since he visited the States, improved methods of wiring, &c., would have been adopted, but no great change seemed to have taken place, excepting in the use of alternating currents. On his visit he obtained an insulator even more crude than the one described by Mr. Addenbrooke. After making inquiries as to the kind of motor used on the constant-current arc circuits, Dr. Thompson expressed his opinion that the alleged greater steadiness of American arc lights was not due to any superiority in the design or workmanship of the lamps, but to the greater personal pride and confidence which the attendants have in the particular system with which they are connected.

Mr. SWINBURNE pointed out the great difference which existed in the management of English and American factories, and thought the system adopted in the latter, where the perfecting of designs and the experimental work are kept quite distinct from the wholesale manufacturing part of the business, was most likely to lead to success. So far, however, he believed machines of English design better than American, for the weight efficiency of the former was generally higher. Referring to Mr. Granville's contention, he said that instead of insulation resistances being given in *megohms per mile*, they should be expressed in *megohm miles* for each size of conductor.

The PRESIDENT, whilst deprecating imperfect work in general, thought it advisable that English electricians should acquire whatever good could be got from the "rough-and-ready" methods adopted in America, and considered that progress might be retarded by waiting too long to

Digitized by Google

attain perfection. He was anxious to know how constant currents were used for motors, and also whether the overhead wires used for tramways interfered with the ordinary street traffic.

Replying to Prof. Forbes' question as to recent advances, Mr. ADDENBROOKE said he had not concerned himself with them, for his object was to see the systems and apparatus in common use. As to motors, he made no inquiries respecting their peculiarities; but as regards meters, he was informed that numbers of the Westinghouse type were in constant use. He agreed with Prof. Forbes about the way in which testing is appreciated, and with Prof. Thompson as regards the interest which the men take in their work: the latter fact he attributed to better wages and greater chances of promotion. Speaking of the insulation of cables, he thought the absolute thickness of insulating material should be stated. In reply to the President's question relating to tramway wires, Mr. Addenbrooke pointed out that they were placed eight or nine feet above the tops of the cars, contact being made by a "fishing rod" connection. In some cases these wires are carried by brackets projecting from poles fixed along the middle of the roadway, the poles being also utilised for supporting arc lamps, and for general lighting circuits.

December 12th.

After the adoption of the Report of the Council, and the passing of the usual votes of thanks, the discussion on Mr. Addenbrooke's Paper, "Electrical Engineering in America," was resumed:—

Mr. LANT CARPENTER, who paid a hurried visit to America during August and September, said he quite concurred in Mr. Addenbrooke's remarks about the temporary character of the work, particularly in the western towns. In many places on the Pacific slope, he found that water power was extensively used, both for arc lighting and for tramway work. One town in Washington, he observed, had laid down electric tramways before making the common roads. Incandescent lamps were comparatively rarely seen in the Far West, and from inquiries he learned that where they had been tried, the stations were so badly managed that the life of the lamps averaged between 200 or 300 hours. Passing on to Canada, he said that Quebec, Montreal, and Ottawa were all lighted electrically by water-power, and in the latter city he was informed that many alternate-current motors of the Tesla type were in constant use. Another fact that struck him was the large numbers of long-distance telephone wires in use in the States. He also noticed that many of the wires were now being put underground.

Mr. G. S. RAM said he could not agree with Mr. Addenbrooke on the glaring character of arc lamps fixed on poles. He greatly preferred the blaze of light in that city to the comparative darkness of London. As regards the character of overhead work, he thought the account given in the Paper was not overdrawn, and in support of this he exhibited a photograph of a building in Broadway, New York, in which hundreds of wires were unintentionally included. On careful examination of the photograph the insulation on some of the wires was seen to be hanging in shreds.

Mr. C. E. SPAGNOLETTI thought the necessities for insulation were so different in England and America that the systems could not be compared on the same basis. To show the great variation of insulation resistances in this country, he said that on the South Wales Branch of the Great Western Railway, the insulation resistance of the telegraph lines varies from several meghoms to a few thousand ohms, according to the weather. He also mentioned the difficulties experienced by Mr. Edison when experimenting in London and at Ealing with his Automatic Chemical Telegraph. The maximum rate he could attain here was 500 words per minute, whereas in America he could get 2,000.

Mr. PREECE, speaking of insulation requirements in the two countries, said that in his opinion the differences arise from the fact that the prevailing winds here are warmed and moistened by passing over the Gulf stream, whilst in America, the shores being washed by polar currents, the winds are cold and dry. Referring to his own visits to America, the speaker said he always benefited considerably by being associated with the "go-aheadedness" of American engineers, and he believed that on visiting this country American engineers derived similar advantages.

Mr. CROMPTON said the Paper deserved a good deal of study, and there were some points upon which he desired further information. For example, the method of preventing vibration mentioned would, if effective, be of great importance, for one would have expected such an arrangement to increase rather than diminish vibration. Judging from the remarks about regulating resistances, he would infer that in this respect America was behind European practice, for on this side of the water such resistances had been done away with. The fact of alternate-current machines not being usually run in parallel (as attested by Mr. Addenbrooke), tended to confirm his (Mr. Crompton's) statements made in his Paper on "Central Station Lighting," read in April, 1888. As regards the boilers described in connection with the Thomson-Houston station at New York, he thought such a design would not be tolerated in this country, for the upper parts of the tubes were liable to get overheated and collapse. Speaking of tramway work, Mr. Crompton said American engineers had been greatly favoured by being allowed to erect overhead wires anywhere and anyhow, but he was afraid such facilities would never be granted in England.

Mr. A. RECKENZAUN deprecated the wholesale condemnation of posts made by Mr. Addenbrooke, and said that many were not unsightly, whilst some were ornamental. He considered the Paper chiefly a criticism of the bad work done in America, and the good work was barely mentioned.

Mr. F. RECKENZAUN concurred in his brother's remarks about the unfair criticism contained in the Paper, and thought the differences of opinion arose from the totally different ideas as to the way in which electrical engineering should be carried out. In the American methods, he said, great skill and ingenuity were shown in combining economy with simplicity and efficiency. Although the arc lamps were not ornamental, yet they were simple and efficient, and their cheap construction admitted of their being universally used. He agreed in general with Mr. Lant Carpenter's remarks on incandescent lighting, but was inclined to believe its limited use was due to the people wanting the biggest and best light obtainable at the price.

Mr. ADDENBROOKE, in reply to Messrs. Reckenzaun, said he had specially mentioned in his Paper that the Thomson-Houston Company were putting up work much better than the average, and as to posts, he was glad to say the tramways companies were making considerable improvements. The arrangement of flooring referred to by Mr. Crompton was not intended to diminish vibration, but to prevent such vibration being transmitted to the brickwork. As regards the boilers criticised by the same speaker, he (Mr. Addenbrooke) could only say that those in charge of them informed him that it was intended to have more of them. It was not his intention to criticise all American electrical engineering in a hostile spirit, for he thought there was little difference in the capacity of English and American engineers. The necessities, however, of the two countries were entirely different, and each had to adapt himself to his own surroundings. The motors used on the arc circuits were, as far as he could learn, simply series ones provided with switches for cutting out parts of the magnet coils. In concluding, Mr. Addenbrooke said he had the opportunity of conversing with many of the American engineers who visited this country in the summer, and all were greatly pleased with the kind and courteous manner in which they were received.

After the thanks of the meeting had been given to the author for his Paper, Dr. S. P. Thompson directed attention to some American blue glass insulators, which he had brought for inspection, and remarked that in a recent American work on electric lighting, which was now being circulated in this country, these insulators are recommended as suitable for almost any purpose.

Mr. Addenbrooke also exhibited a piece of the cable used in underground work in New York, the chief point of interest being the hardness of the insulating material employed.

ON THE LEAKAGE OF NEGATIVE ELECTRICITY CAUSED BY SUN AND DAYLIGHT.*

BY T. ELSTER AND H. GEITEL.

In reference to the theory of atmospheric electricity propounded by Arrhenius,† we have recently made a series of experiments to ascertain whether sun- and daylight have the property of gradually withdrawing the charge from negatively electrified bodies. M. Hoor‡ alone has established such an action, while all other observers, so far as we know, have not been able to discover any. We have therefore been greatly surprised to find that not only sun- but also ordinary diffused daylight can under suitable conditions rapidly discharge a negatively electrified body.

A zinc dish, 20 centim. in diameter, is exposed in the open on an insulating support in such a manner that it is not acted on by negative electricity, and is put in conducting communication with a quadrant-electrometer, or an Exner's electroscope, and further, is so arranged that the dish can be put in the dark or light at pleasure. The following phenomena can then be observed, which, it is true, are already known from experiments on ultra-violet light. The dry dish polished with emery completely loses a negative charge of 300 volts in 60 seconds: an equally high positive charge is retained. The loss of the negative charge ceases as soon as the dish is put in an entirely dark room; it is considerably enfeebled if the sun's rays pass previously through a glass plate. A decided collapse of the leaves of the electroscope takes place when the dish is merely exposed to the blue light of the sky. If the dish is filled with hot or cold water the action is completely extinguished; a moist cloth stretched over it acts in like manner. By being illuminated the finely polished plate acquired a spontaneous charge of +2·5 volts, which by blowing on the plate could be still further increased.

The experiments are much simpler when the metals to be illumined are directly fixed in the form of wire to the knob of an Exner's electroscope. If freshly-polished wires are used—aluminium, magnesium, or zinc—a permanent negative electrification in the sunlight in the open is not at all possible. It is completely discharged in less than five seconds. Magnesium and aluminium wires act here more energetically than zinc ones. There is a perceptible collapse of the leaves when the former are used, even with the action of diffused evening light. It is also interesting to note that freshly-polished wires of the metals in question act as if an ignited body were attached to the electroscope. If an electroscope so arranged is taken to an open field, the leaves diverge with the use of freshly-polished wires with positive electricity, arising from the influence of the electricity of the air. In all these cases an abnormal diffusion of positive electricity could not be observe d. The experiments were made from the middle of May to the midd le of June in this year (1889).—Wiedemann's *Annalen*, Vol. XXXVIII., p. 40 (1889).

* From the *Phil. Mag.*, November, 1889.

† *Meteorol. Zeitschrift*, Vol. V., p. 297, 1888.

‡ *Rep. der Phys.*, Vol. XXV., p. 105, 1889.

Digitized by Google

The Electrician.

Published every Friday. Price Fourpence; Post Free, Fourpence Halfpenny.
Editorial, Publishing and Printing Offices:

No. 1, SALISBURY COURT, FLEET STREET, LONDON, E.C.

Telephone No. 2714. *Telegrams:* "ELECTRICIAN NEWSPAPER, LONDON."

All Communications to be addressed to "THE ELECTRICIAN," *1, Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN."

All letters intended for insertion in "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. Subscribers should receive their copies by the first post on Friday morning.*

"THE ELECTRICIAN" *is on sale at the railway bookstalls throughout the United Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices as above.*

SPECIAL NOTICE.

Owing to the increase in the number of pages of "THE ELECTRICIAN," in order to partly cover the increased postage, we have been compelled to revise the rates for Foreign Subscriptions, which are now as follows:—

	3 months.	6 months.	12 months
For Foreign Parts and Colonies:—	s. d.	s. d.	s. d.
Within Postal Union	6 6	12 6	24 0
Aden, Borneo, Ceylon, China, India, Japan, Java, Labuan, Mozambique, New Caledonia, Persia, Philippine Islands, Siam, Transvaal, and Zanzibar	7 6	14 6	28 0
The rates for the United Kingdom remain as follows:—	5 0	10 0	19 6

TO ADVERTISERS.

"THE ELECTRICIAN" *offers exceptional advantages to Advertisers.* **It has the largest circulation of any English Electrical paper, and circulates all over the World.**

Particulars relating to Advertisements will be promptly forwarded on application to the office.

TRADE ADVERTISEMENTS *intended for the current issue must be handed in not later than First Post on Thursday morning.*

SMALL PREPAID ADVERTISEMENTS *(for Rates see page xiii.) are accepted up to 4:30 p.m. on Thursday.*

TECHNICAL PRINTING.

"THE ELECTRICIAN" PRINTING AND PUBLISHING COMPANY (LIMITED) *beg to inform Electricians, Electric Light Engineers, &c., that they make a specialty of Technical Printing, and have a Staff thoroughly acquainted with Electro-Technology. They can, therefore, promise Accuracy and Despatch in the Printing of Electrical Catalogues and Electro-Technical Literature generally.*

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.

Royal 8vo.

Early in each year is issued "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK. *The* DIRECTORY *was established in 1883, and the 1889 Edition, which is now on sale, consists of more than 600 pages of printed matter. Every care is taken to make the names and addresses of all persons engaged in the Electrical Industries absolutely accurate. Useful Tables and Electrical Formulæ are given, together with popularly-written Biographical Notices of the leading Electricians, Electrical Engineers, &c., accompanied in many cases by Portraits.*

The issue for 1890, which will be still further enlarged and improved, is in active preparation. New Names and Addresses, Corrections, Advertisements, &c., should be forwarded at once to the Publishing Office, **1,** *Salisbury-court, Fleet-street, London, E.C.*

CONTENTS OF THE CURRENT NUMBER.

NOTES 157
Magnetism in Iron and Other Metals.—I. By Prof. J. A. Ewing, F.R.S. Illustrated.. 161
The Keeley System of Working Telegraph Circuits. Illustrated 162
The Institution of Electrical Engineers—
"Electrical Engineering in America." Concluded..... 164
On the Leakage of Negative Electricity caused by Sun and Daylight. By T. Elster and H. Geitel 167
LOCAL AUTHORITIES AND THE ELECTRIC LIGHT 168
On the Heating of Conductors by Electric Currents. By A. E. Kennelly. Illustrated. Continued..... 169
The Electric Light in English Towns 172
CORRESPONDENCE—
Disc Winding.—W. B. Sayers 174
CORRESPONDENCE—*Continued.*
The Behaviour of Flames in the Neighbourhood of Influence Machines.—J. T. Bottomley..... 174
Electrifying Steam.—Oliver J. Lodge 174
The Electric Light at Temesvar.—F. W. Clements..... 174
The Priestman Oil Engine. Illustrated..... 174
Legal Intelligence..... 175
Trade Notes and Notices 175
PATENT RECORD 176
COMPANIES' MEETINGS, &c.—
The Gülcher (New) Electric Light and Power Company (Limited)..... 177
The Maxim-Weston Electric Company (Limited)..... 177
Metropolitan Electric Supply Company (Limited)..... 178
New Companies Registered ... 179
City Notes, &c..... 179
Companies' Share List 180

"THE ELECTRICAL WORLD" OF NEW YORK.

Arrangements have been made by which "THE ELECTRICAL WORLD" OF NEW YORK *can be obtained from* "THE ELECTRICIAN" *Office, 1, Salisbury-court, Fleet-street, London, E.C.*

The Rate of Subscription (payable in advance), is **£1 1s. 0d.** *per annum.*

Single Copies of "THE ELECTRICAL WORLD" *can also be obtained,* **price 6d. each; post free, 8d.**

"THE ELECTRICIAN" *can also be obtained of the* W. J. JOHNSTON COMPANY (LIMITED), "THE ELECTRICAL WORLD" *Office, Times Building, New York, U.S.A.*

SPECIAL NOTICE.

"The Electrician" will be Published, as usual, on Friday Morning in Christmas week, but Contributors and Advertisers will greatly oblige by forwarding their communications not later than Tuesday's post, as the Editorial, Printing, and Publishing Offices will be CLOSED on WEDNESDAY and THURSDAY, December 25 and 26.

LOCAL AUTHORITIES AND THE ELECTRIC LIGHT.

On several occasions recently we have commented somewhat fully on the singular rapidity with which the country has been overspread by electric lighting Provisional Orders; but in every case our remarks were confessedly subject to modification by fuller information not then at our disposal. This was especially the case in respect to the attitude of local authorities towards outside companies desirous of applying for powers within the municipal boundaries. We endeavoured to be fair to both parties, offering all the excuse we could think of for hostility on the one side, and deprecating any undue pertinacity on the other. Where local bodies were genuinely anxious to take up the matter on their own account, it seemed to us that for private undertakers to push themselves forward in opposition would result only in failure, and tend rather to cast discredit on the Electric Lighting Acts generally. The powers and dignities of local authorities have been greatly enhanced of late, and to provoke their united opposition would be not only futile, but highly impolitic, seeing that most of the electric lighting companies, if not permitted to undertake the installations, might do business by supplying the requisite plant. The action of some of the corporate bodies might not be altogether

Digitized by Google

disinterested or straightforward; but this, perhaps, could be said also of some of the companies, and as the Board of Trade can enforce a more effectual control over the former than over the latter, our advice was to let things take their course.

The fuller information to which we have alluded has reached us a little sooner than was expected. From several well-informed quarters protests have come to hand indicating a widespread suspicion that the local authorities, in many instances, are making common cause against the applicant companies merely for the purpose of keeping the electric light out of the towns altogether. This is said to be the case in places even where the gas lighting is in private hands, the idea being to prevent the inroad of a second monopoly, but with no serious idea of undertaking the new lighting business on their own account. If only time enough can be gained, it is thought that the private undertakers will disappear from the field, and that then the municipal applications can be quietly dropped. The worst offenders, however, seem to be those authorities who have acquired the local gas works, and whose "gas committees" are displaying a notable activity is seeking Provisional Orders, or private Acts of Parliament, to establish electric lighting works as well. On the face of it, such sudden desertion of the old love does not augur well for the new; and it is not surprising that disappointed electrical engineers are roundly charging the local lighting committees with a dishonest flirtation got up for the purpose of leaving the object of it forlorn and deserted.

But we have more solid grounds to go upon than the mere insinuations of rejected suitors. For our present purpose it will be sufficient to single out one conspicuous example of the kind referred to as confirmatory of the suspicions which have been openly expressed to us in respect to several others. At Glasgow, for instance, only the other day, the Town Clerk reported to a thinly-attended meeting of the Town Council, that the Gas Committee had decided to lodge with its memorial for an electric lighting Provisional Order a statement that a sum not exceeding £250,000 was proposed to be expended on the scheme. Although barely a quorum of members was present, this quarter of a million was sanctioned after a few minutes' desultory conversation, the whole tenor of which seemed to us as unreal as the proposal itself. It is only about two years since the Glasgow Corporation obtained £160,000 to extend the local gas works, and most of this money is spent. To suppose that they now intend to spend another £250,000, or anything like that sum, on electric lighting, is to credit them either with folly in the past or recklessness as to the future; and we find it hard to believe in either where Scotchmen are concerned. A similar observation applies to Edinburgh, where the acquisition of the gasworks dates only from last year; yet this is one of the places mentioned at the Glasgow meeting as acting conjointly with that city and with Aberdeen and Dundee in order to be properly represented in their procedure before Parliament next Session. There is reason to believe, as we have already hinted, that the combination here foreshadowed is not confined to Scotland, and that it extends, or will shortly be made to extend, to some of the more important gas-manufacturing Corporations south of the Tweed.

Now it would be idle to underrate the gravity of this combination, if it really exists for the purposes suspected; and that our apprehensions have a solid foundation is borne out by the fact of none of these corporate bodies making the least move towards obtaining electric lighting powers until applications were put forward by outsiders. We commend these considerations to the attention of the Committee of the Electrical Section of the London Chamber of Commerce, whose sources of information may be more ample than our own, and who, if our conjectures are found to be true, will no doubt take steps to protect the interests they have been elected to represent. It will not be difficult for the Committee to devise means to test the sincerity of the combination above referred to, by setting up a genuine case before the Board of Trade for admission to the sacred ground of one or more of these Corporations, and to show good cause for outside competition. Of course the Board will lean to the side of the local authorities; and we think rightly so, for they have a trust to discharge to their constituents which ought not be lightly set aside. But, on the other hand, the Electric Lighting Acts impose duties; and the Board of Trade have no choice but to see that the inhabitants are not debarred the use of electricity where they may desire it by any factitious opposition on the part of the local gas committees. In the end, probably the constituents will have to decide the matter by their votes; and to this there can be no objection whatever. What we do decidedly object to is to its being prejudged and settled by a small conclave who are more or less personally interested in maintaining the integrity of the Corporation gas works. Electricians would be content to have but a footing in the disputed areas; and this we think they are entitled to under the Acts, unless good reason can be shown to the contrary. Probably the local authorities are reckoning too much on their dignity and too little on the expressed intention of the Board of Trade to require that the electric light shall be supplied to the public either by local authorities, or, failing them, by any properly equipped company who may desire to undertake the task. Our friends, therefore, may feel reassured as to the ultimate result; and their Christmas holiday, which this year ought to be especially cheerful, need not be spoilt by the obstructive tactics of local magnates.

ON THE HEATING OF CONDUCTORS BY ELECTRIC CURRENTS.*

BY A. E. KENNELLY.

(Continued from page 145.)

The Heating of Bare Copper Wires and Strips Suspended in Air Within Doors.

It has been shown by Prof. Forbes and others that for bare cylindrical wires suspended in air, the temperature elevation produced in them by a current will be directly proportional to the square of the current and inversely to the cube of the diameter, provided that the loss of energy per unit surface of wire per second, known as the emissivity, be itself directly proportional to the temperature elevation. This assumption, though frequently made, is recognised to be untrue, and consequently this law cannot apply rigorously to suspended bare wires, just as it has been shown to be only approximately true for empanelled wires. Experiment shows that the emissivity rises rapidly with the rise of temperature, being in some cases nearly twice as great per degree Centigrade at 100 degrees as it is at 20°C. of temperature elevation. Hitherto in calculating the limiting temperature of a bare wire suspended in air the emissivity has been generally taken from the data supplied by the careful experiments of Messrs. McFarlane and Nichols, who observed the rate of cooling of large metal spheres in special enclosures, conditions which are not fairly applicable to the cooling of wires, and which cannot, as Prof. Forbes himself pointed out, be strictly depended upon for that purpose. He suggested that the effect of convection was not proportional to the surface, while radiation was; and experiments have verified this belief. Thus the emissivity for a polished copper surface in the experiments of McFarlane and Nichols was about 0·000168 therm per degree Centigrade between 0°C. and 60°C. With this value Forbes and others have been led to greatly under-estimate the carrying capacity of bare suspended wires. In the table accompanying his Paper already mentioned the calculated currents to raise the temperature of bright copper wires

* Abstract of Report read before the Edison Convention at Niagara Falls, August, 1889.

Digitized by Google

of 0·040in. and 0·120in. diameter 49°C. are 6·5 and 33·5 amperes respectively, while experiment shows that about twice as much current is needed in each case. In fact, the emissivity per degree Centigrade has been found to vary from 0·00019 therm, with a thin, flat, bright, copper strip, to 0·001364 therm with a bright copper wire 0·0356in. (0·0904 centimetre) diameter, at about 50°C. temperature elevation, or, in the latter case, some eight times as great an emissivity as that quoted from the previous data. A hot wire suspended in air parts with its heat both by convection and radiation. These two processes are essentially distinct, and are governed by different laws, so that the complete treatment of the subject can only be attained by dealing with each separately and summing their effects. The experiments to be described have succeeded in determining up to temperature elevations of 100°C. the separate rates of convection and radiation, together with the conditions to which they are independently subject. It is true that to determine all these conditions accurately would demand much further investigation, but the results appear to be at least reliable as a good first approximation. Instead of dealing with the emissivity in therms, as has been customary, it will be more simple and direct to give all the results in watts.

Fig. 3 A B C represents the temperature elevation measured with different current strengths passing through uninsulated copper conductors suspended in air within doors. Five different conductors were tested, and of these four were copper wires of diameters from 0·0356in. (0·0904 cm.) to 0·1345in. (0·341 cm.). The fifth was a strip of bright brush copper, 1in. (2·54 cms.) wide and 0·0065in. (0·0165 cm.) thick. Curves I., II., III., IV., V., VI., and VII. are the traces of the observations made upon them. Their surfaces were all brightened with fine emery paper, except that of the strip, which needed no polishing. The wires were suspended about 8ft. (250 cms.) above the floor, between opposite walls of the laboratory, in the still air with the windows closed. These precautions were taken because it was found that a comparatively small disturbance of the air exercised a decided cooling influence on the wire. Thus a fan gently waved beneath and at right angles to one of these 25ft. lengths of wire under test produced a diminution in its resistance that was plainly discernible, and arrangements were therefore made to keep the air as free from disturbance as possible. For the same reason all the observations, though they reached their practical maxima much more quickly than had been the case with the panelled wires, were more variable and never remained quite steady. The reading had consequently to be repeated several times and means taken to obtain fair results.

The emissivity of the strip (in its upright position, to be later described) proved to be 0·24 watt per linear centimetre, at 50°C. temperature elevation, its surface per centimetre being 5·11 sq. cms., while the emissivity of the smallest wire was 0·08 watt per linear centimetre at the same temperature elevation, its surface per centimetre being 0·284 sq. cm. Both these measurements being referred to the unit surface instead of unit length, give, respectively, 0·047 and 0·28 watts per sq. cm., thus making the emissivity of the small wire about six times as great as that of the strip for the same temperature elevation. From this great discrepancy it appeared probable that the convection, instead of being proportional to the surface, like radiation, was equal in both cases, or nearly so; for if the convection had been proportional to the surface the mere difference in the form of the two conductors, whose surfaces were of similar appearance, could hardly account for so large a discrepancy. By assuming the convection to be equal for both wire and strip, a pair of simultaneous equations was supplied by each pair of corresponding elevation points in the observation curves, thus giving radiation and convection independently for each such pair. The results for the radiation obtained in this way are:

Radiation for both wire and strip.

At °C. Temperature elevation.	Watts per sq. cm.	At °C. Temperature elevation.	Watts per sq. cm.
10	·004765	60	·04103
20	·01057	70	·04995
30	·01720	80	·05927
40	·02466	90	·06796
50	·03312	100	·07790

A rate of increase considerably beyond arithmetical progression. The test of the accuracy of the assumption on which these figures are obtained must be the accordance of this series with the laws of radiation as they are independently known.

MM. Dulong and Petit have published in the seventh volume of the *Annales De Chimie et de Phyisque*, 1817, a veritable poem in physical investigation upon the laws of cooling bodies. In their experiments the radiation was found to vary with the temperature elevation in geometrical progression expressed by the equation:

$$h = c\,(1{\cdot}0077)^{\theta}\left\{(1{\cdot}007)^{t} - 1\right\};$$

here h is the quantity of heat lost by radiation from a hot body per square centimetre per second; c, a constant depending on the nature of the radiating surfaces; θ, the temperature of surrounding bodies, and t the temperature elevation of the hot body in degrees Centigrade.

Taking this formula as representing the best existing knowledge of the rate of radiation with temperature, the test of the above assumption is in the accordance of the above series of calculated radiations with a similar series obtained from Dulong and Petit's equation, making t successively 10, 20, 30, &c., up to 100. The numbers so arrived at are:

$1{\cdot}0077^{10} - 1 = {\cdot}0797$	$1{\cdot}0077^{50} - 1 = {\cdot}4675$	$1{\cdot}0077^{80} - 1 = {\cdot}8471$
$1{\cdot}0077^{20} - 1 = {\cdot}1658$	$1{\cdot}0077^{60} - 1 = {\cdot}5844$	$1{\cdot}0077^{90} - 1 = {\cdot}9944$
$1{\cdot}0077^{30} - 1 = {\cdot}2587$	$1{\cdot}0077^{70} - 1 = {\cdot}7108$	$1{\cdot}0077^{100} - 1 = 1{\cdot}1534$
$1{\cdot}0077^{40} - 1 = {\cdot}3591$		

To test the degree of accordance between the two series, the fourth element corresponding to 40°C. (that being probably the most favourably situated for accuracy in observation) may be multiplied by 0·06866 to make it coincide with the calculated radiation 0·02466, and all the terms of the latter series may be similarly multiplied by the same factor. We then obtain the results given in the following table:—

Temp. elevation.	Dulong and Petit's series.	Factor of comparison.	Dulong and Petit's series referred to 40°C. elevation.	Calculated series from wire and strip.	Discrepancy.
Deg.					
10	·0797	·06866	·05473	·04765	– ·0007
20	·1658	...	·01138	·01057	– ·0008
30	·2587	...	·01776	·01720	– ·0006
40	·3591	...	·02466	·02466	Standard.
50	·4675	...	·03210	·03212	+ ·00002 min.
60	·5844	...	·04013	·04103	+ ·0009
70	·7108	...	·04881	·04995	+ ·0011
80	·8471	...	·05817	·05927	+ ·0011
90	·9944	...	·06827	·06796	– ·0003
100	1·1534	...	·07919	·07790	– ·0013 max.

This agreement must be considered very satisfactory, and it is difficult to suppose it merely coincidental. It not only strengthens the reliance to be placed on Dulong and Petit's law, but it also amounts to a demonstration that the convection does not depend upon the surface, or that at least it can only do so in a very limited degree.

The radiation in watts per square centimetre from a surface of bright copper may therefore be accepted as $0{\cdot}0687\,(1{\cdot}0077^{t} - 1)$ under the condition of these experiments. But Dulong and Petit's law requires that this factor 0·0687 should itself be a function of the temperature of surrounding bodies, or, in other words, that the radiation loss from a hot wire for a given temperature elevation increases with the absolute temperature. It may therefore be assumed that

$$\cdot06866 = c\,(1{\cdot}0077)^{\theta};$$

and in these experiments θ, the temperature of the surrounding air, was about 26°C., so that

$$c = \frac{\cdot06866}{(1{\cdot}0077)^{26}} = \cdot05625.$$

Whence the complete expression for the radiation from a bright copper wire in watts per square centimetre is:

$$\cdot05625\,(1{\cdot}0077)^{\theta}\,[(1{\cdot}0077)^{t} - 1].$$

It is to be observed, however, that this factor $(1{\cdot}0077)^{\theta}$ is a deduction only, as yet not verified by experiment. It is difficult to decide this point in the summer season, but it is hoped to determine the question of its existence experimentally during the ensuing winter by observing whether the radiation does vary to such a degree for giving temperature elevations when the temperature of surrounding bodies is changed. Should this factor's existence be verified it would completely establish the application of Dulong and Petit's law. If, on the other hand, the variation is not to be detected, while it would certainly weaken the position, the general evidence, apart from Dulong and Petit's law, is sufficient to maintain the use of the term $[(1{\cdot}0077)^{t} - 1]$, while the factor 0·06866 would necessarily be regarded as independent of θ. With this reservation, the retention of the factor is probably justified, especially as for most practical purposes the question is not a vital one.

The following table gives the radiation in watts per square centimetre of bright copper for $\theta = 25$°C., and if the factor $(1{\cdot}0077)^{\theta}$ be found to have an experimental existence it will be a simple matter to amplify the table for various values of θ from zero to 30°C.

Digitized by Google

RADIATION TABLE *in Watts per Square Centimetre for Bright Copper.*

Temper. Elevation.	$(1{\cdot}0077^t - 1)$	Radiation.	Temper. Elevation.	$(1{\cdot}0077^t - 1)$	Radiation.
Deg. Cent.			Deg. Cent.		
5	·0391	·002665	55	·5249	·0358
10	·0797	·00543	60	·5844	·0398
15	·1219	·00831	65	·6464	·0441
20	·1658	·0113	70	·7108	·0484
25	·2114	·0144	75	·7777	·0530
30	·2587	·0176	80	·8471	·0577
35	·3080	·0210	85	·9194	·0627
40	·3591	·0245	90	·9944	·0678
45	·4123	·0281	95	1·0724	·0731
50	·4675	·0319	100	1·1534	·0786

The radiation is thus roughly 0·0006 watt or 0·00014 therm per square centimetre per degree Centigrade, increasing in geometrical ratio; and one square metre of bright copper at 100°C. elevation would radiate about 800 watts.

The same series of simultaneous equations which gave the radiation values furnish also the convection for wire and strip and its rate of change. Figs. 3, A, B, C, gives the result of the analysis. Curves Nos. I., II., IV., and V., in Fig. 3A, represent the total emission in watts per linear centimetre as actually measured, and as composed of both radiation and convection. In Fig. 3C, the total radiation obtained in

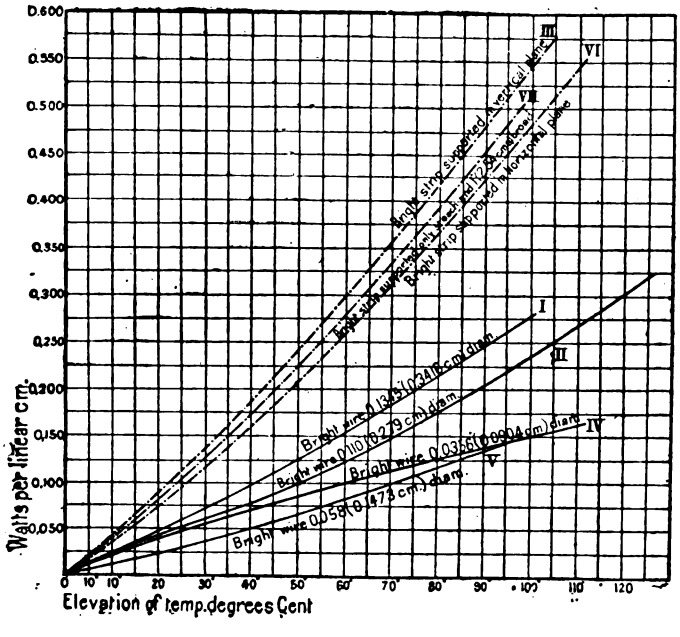

Watts per linear cm.
Elevation of temp. degrees Cent.
Bright wire 0·0356 (0·094 cm) diam.
Bright wire 0·110 (0·279 cm) diam.
Bright wire 0·0356 (0·094 cm) diam.
Bright wire 0·056 (0·473 cm) diam.

FIG. 3 A.—Emissivity Curves.

the above manner is represented in the corresponding curves I., II., IV., and V., drawn to the same scale. The difference at each pair of corresponding points between the total emission and the total radiation represents the convection loss, and this is given by the lower set of curves, I., II., IV., and V., in Fig. 3B to the same scale. It will be observed that the convection was nearly the same in each case, the effect of increasing the diameter of the wire from 0·0356in. (0·094 centimetre) to 0·1345in. (0·3476 centimetre), that is, nearly four times, only appearing to increase the convection 20 per cent.; thus corroborating the results arrived at by the test of agreement with Dulong and Petit's law. The convection appears to increase rather more rapidly than the temperature elevation, except in the case of the smallest wire. This result is not in accordance with those of Dulong and Petit, who found the convection in their experiments with cooling spheres to increase as the power 1·233 of the temperature elevation, or according to the factor $t^{1\cdot233}$. It is quite possible, however, that the convection for spheres may not be the counterpart of that for long wires, and it is to be observed that not only are the laws of convection a branch of hydrodynamics more complex than those of radiation, which does not appear to vary with the form of surface, but the number and precision of these particular experiments scarcely warrant any more definite deductions to be made in this direction. For practical purposes therefore it will be sufficient to take a mean value of the convection and to assume it to be proportional to the temperature elevation until further investigation may afford more precise information. We may, therefore, take the loss of heat by convection from any wire at the mean value of 0·00175 watt per linear centimetre, in still air for each degree Centigrade of temperature elevation; that is, one kilowatt for every 114 metres at 50°C. temperature rise. Fig. 3A also shows that the total emission of a wire per centimetre may rise faster or slower than the temperature elevation, or may even trace a straight line proportional to the elevation for a certain distance, according to the dimensions of the wire and the relative proportions of convection and radiation in its

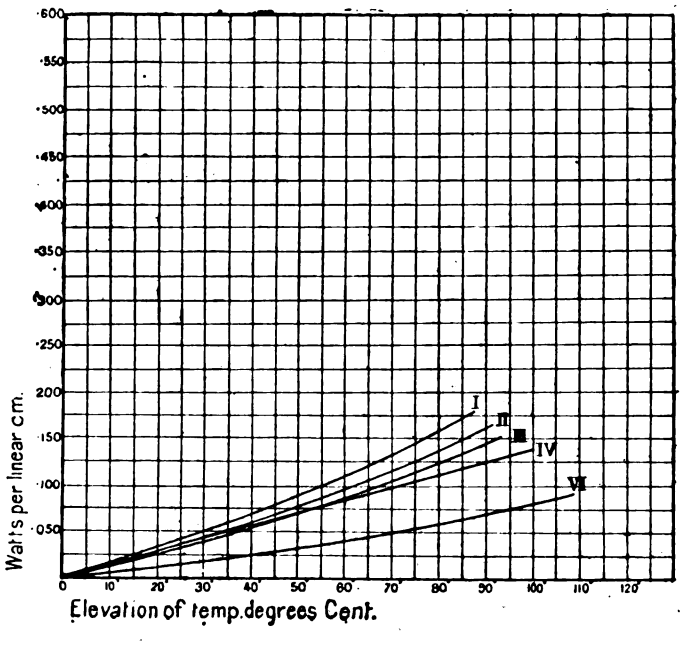


FIG. 3 B.—Convection Curves.

cooling. The smaller the wire the greater the likelihood appears to be of the rate of emission falling behind the rate of rise in temperature.

Experiments were next made to determine the amount of variation that a difference in quality of surface could effect in the rate of radiation. For this purpose five wires of the same dimensions and material—that is to say, five lengths of the same wire—were suspended parallel and their surfaces coated with different substances.

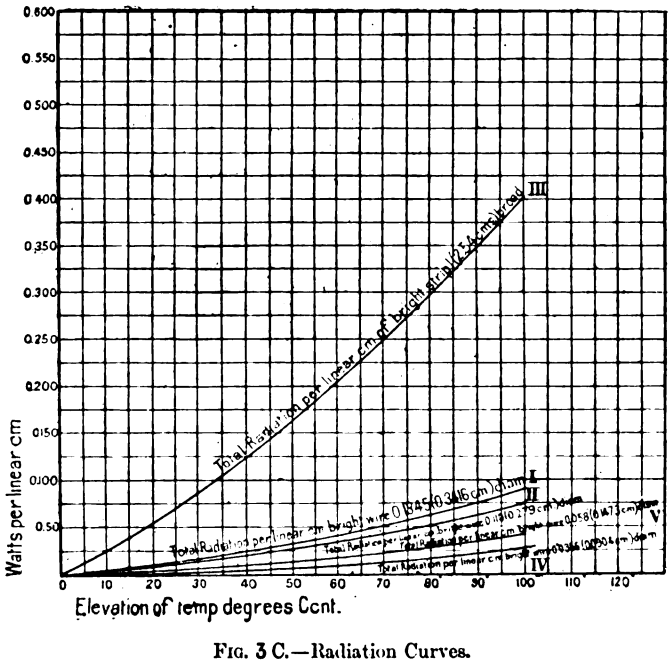


FIG. 3 C.—Radiation Curves.

On another occasion five lengths of the same strip were treated and experimented upon in a similar manner. The results showed that in still air a black coating of sulphide of copper, produced by painting the bright surface with a solution of sulphide of sodium, reduced the temperature elevation corresponding to any given current nearly 30 per cent. both for wires and strips; while a coating of lampblack and shellac (dead black carpenter's

Digitized by Google

varnish) similarly reduced the temperature of the strips nearly 50 per cent. This has a useful bearing upon bare copper conductors within doors, say in an illuminating central station, for if their surfaces are so large that the heat loss takes place principally by radiation (and for surfaces above 5 square centimetres per linear centimetre convection plays but a small part), the saving of energy produced by painting the conductors with this varnish will, through the lowered temperature and resistance, amount to $\frac{t}{6}$ per cent., where t is the previous temperature elevation. So that if these conductors be maintained at 50°C. elevation in the bright state this will fall to about 27°C. after painting, with a resultant saving of about 8 per cent. of the whole energy previously generated by the current in the painted length. This applies not only to bright copper, but also to copper that has become slightly tarnished by age, but may not apply equally to copper whose surface is encrusted with dust or smoke.

By first determining the radiation and convection for the bright wire and strip, then assuming the convection to be equal for the other coated wires and strips respectively, the mean ratio of the radiation from each quality of surface to the radiation of bright copper was calculated to be as follows :—

For the wires.—Thin coating of brown shellac varnish, 1·62 ; thick coating of copper sulphide (CuS), 2·34 ; thick coating of lampblack made adherent by molasses, 2·05.

For the strips.—Thick coating of brown shellac varnish, 1·84 ; rather imperfect and thin coating of copper sulphide, 1·54 ; lampblack by deposit from smoky candle, 1·42 ; thin coating of varnish, lampblack, and shellac, 2·02.

The coating of copper sulphide was not so successful in promoting radiation with the strips as with the wires, partly owing, however, to imperfect cooling. The necessity for a compact adherent layer in obtaining active radiation is also shown, for while lampblack, deposited from a flame, only added 42 per cent. to bright radiation, lampblack applied with thin shellac varnish doubled it. We may therefore take the radiation from a properly blackened wire as double that from a bright wire.

Experiments were also made with two strips of bright copper to ascertain how far their convection was affected by their plane of suspension. In the above-mentioned tests of strips they were all secured at their extremities to lie flat ; but toward their centre they each dipped to one side or the other out of the horizontal plane, making a dip of about 45deg., and the following tests were made to determine whether the convection depended to any extent upon this angle : These two strips were supported in air at about every 3ft., one of them being fixed in the vertical plane, while the other rested flat above all the supports. Their perpendicular distance apart was 8in. (21 centimetres). The testing current was sent through them in series and the temperature elevations determined for each in the usual way. Curves III. and VI., Fig. 3A, represent their relative behaviour. In the first trial the temperature elevation of the flat strip reached 120°C., at 101 amperes, while that of the upright was only 102·5°C. To make certain that this difference was not due to any inequality of radiating power, the strips were exchanged in position, the upright one being now flat, and *vice versâ*. On repeating the test, the temperature elevation of the flat strip reached 120·5°C. at 100 amperes, while that of the upright strip was 101·3°C., practically the same result, and the only means of accounting for the difference was the plane of the strips. The diagram shows that the emission of the upright strip was greater than that obtained from it in the previous test while unsupported and drooping, and the emission from the flat strip less—a result quite in accordance with expectation. Fig. 3B gives the calculated values of the convection from the upright and flat strip. The latter is seen to be about 45 per cent. less than the former, a rather surprising difference, for it would indicate that, supposing the upper surface of the flat strip to be equally affected by convection to the same degree as one side of the upright strip, the convection from the lower surface would then be ten times less.

The final results of the experiments on bare wires in still air point to the following means of calculating the current strength necessary to raise any given copper wire to a certain temperature elevation :—

Let d be its diameter in centimetres ;
t ,, the given temperature elevation ;
r ,, its resistivity at 0°C., in ohms ;
θ ,, the temperature of surrounding objects ;
m ,, the coefficient of surface for radiation.

Let $t+\theta=T$, the temperature attained by the wire.

Then its resistance per centimetre will be—

$$\frac{4\,r\,(1+\cdot00388\,T)}{\pi\,d^2}\text{ ohms.}$$

The energy developed per centimetre by a current of c amperes will be—

$$\frac{4\,c^2\,r\,(1+0\cdot00388\,T)}{\pi\,d^2}\text{ watts per centimetre.}$$

The heat convected from it will be : $\cdot00175\ t$ watts per centimetre.

The heat radiated from it will be :

$$d\,m\,\pi\times\cdot0687\,[(1\cdot0077)^t-1]\text{ watts per centimetre.}$$

Or if the radiation for t deg. elevation be taken from the previous table and denoted by R^t :

The total radiation per linear centimetre $=d\,m\,\pi\,R_t$ watts. Equating the gain and losses,

$$\frac{4\,c^2\,r\,(1+\cdot0388\,T)}{\pi\,d^2}=\cdot00175\,t+d\,m\,\pi\,R_t\ ;$$

whence,

$$c=\cdot886\,d\sqrt{\frac{d\,m\,\pi\,R_t+\cdot00175\,t}{r\,(1+\cdot00388\,T)}}\ ;$$

for copper of 98 per cent. conductivity $r=1\cdot65\times10^{-6}$; so that simplifying—

For bright wires :

$$m=1,\ c=28\cdot9\,d\sqrt{\frac{570\,Q\,R_t+t}{1+\cdot00388\,T}}\ ;$$

for blackened wires :

$$m=2,\ c=28\cdot9\,d\sqrt{\frac{1140\,Q\,R_t+t}{1+\cdot00388\,T}}\ ;$$

where $Q=\pi\,d$, the circumference of the wire.

The following table of current strengths capable of elevating the temperature of bare copper wires of 98 per cent. conductivity suspended in still air, 5 degrees, 10 degrees, 20 degrees, 40 degrees, and 80 degrees above surrounding air and objects at 20°C., has been calculated for bright and blackened wires by the use of these formulæ It will be observed that the currents are given up to 1,500 amperes,

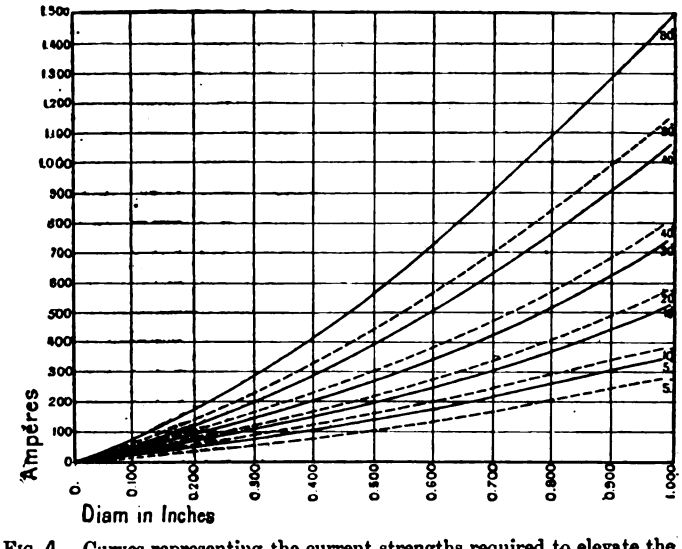


Fig. 4.—Curves representing the current strengths required to elevate the temperature of wires of diameters up to 1in., 5, 10, 20, 40, and 80°C. ; for bright and blackened copper of 98 per cent. conductivity in still air at 20°C. Broken lines refer to bright copper; full lines refer to blackened copper.

while 100 amperes was the experimental limit to which this series was carried. To present, however, a comparison of the results calculated in the table with those actually measured up to that limit, the following may be noticed :—

For elevation of—

5°C., the observed current was	24	amperes ; tabulated,	24		
10°C., ,, ,,	34·5	,, ,,	34		
20°C., ,, ,,	47·5	,, ,,	47·5		
40°C., ,, ,,	67	,, ,,	66		
80°C., ,, ,,	92	,, ,,	91		

Fig. 4 gives the above table in graphic form, the continuous lines representing bright, and the broken lines blackened, wires.

(To be continued.)

THE ELECTRIC LIGHT IN ENGLISH TOWNS.

The following extracts from Appendix A of the elaborate report recently presented to the Dublin Town Council by the Electric Lighting Committee may prove of interest :—

Liverpool.—The Liverpool Electric Supply Company have had a licence from the Board of Trade since the early portion of last year, and this year have got a Provisional Order with the consent of the Corporation. In this Provisional Order (which is for certain portions of the City only) the Corporation have had inserted the requisite clauses for their protection as

Digitized by Google

regards the mode of laying the mains and taking up and reinstating the pavements disturbed, and charge the company the actual cost, with an addition of 10 per cent. The bills for these street openings are made out and paid weekly, and the Corporation, under the provisions of the order, hold in reserve £500 of the company's money. This sum has always to be maintained as a deposit for the protection of the Corporation.

The company charge for the electric light the following, viz. :—For the first 100 hours (per quarter) at the rate of 1s. per Board of Trade unit; between 100 and 200 hours at the rate of 8d. per Board of Trade unit; any number of hours over 200 at the rate of 4d. per Board of Trade unit. The underground wires for electric lighting are now being laid in the thoroughfares of the city. The method adopted is to place the tube containing the wires in a cast-iron casing, with sockets (somewhat resembling a square rain-water pipe cut in two parts longitudinally); this trough being then filled with bitumen, and finally covered on top with cement, forms the complete arrangement for protecting the cables. The new electric mains and cables have not been yet brought into requisition, and up to the present time there is no public electric lighting in Liverpool. The system will be all high tension, reduced in the ordinary way by transformers. Siemens' dynamos and Willans' steam-engines are used in the several stations in the city. The average annual period of public lighting by gas is 4,000 hours, and the price is from 2s. 9d. to 3s. per 1,000 cubic feet.

Bradford.—The gas works in Bradford are the property of the Corporation. The Corporation, under a Provisional Order, is about to distribute the electric current for domestic lighting, motive power, and other purposes. It is not intended to introduce public electric lighting under the scheme until it is ascertained to what extent the public will avail themselves of the electric supply, and also in consequence of the great success of the gas undertaking. The new light is at present intended for the illumination of houses and buildings in the central portions of the town. The necessary works are estimated to cost £24,000. The Corporation proposes to supply the light at a charge of 5d. per Board of Trade unit. In regard to machinery and plant, the central station contains three Siemens dynamos, each of 600 amperes and 150 volts; two engines by Willans and Robinson, and one by Marshall, Sons, and Co., each of 150 horse-power indicated; three steel boilers by Holdsworth and Sons, of Bradford (Lancashire type). The engine room is 60ft. by 21ft. Eight and a-half miles of electric mains have been laid, the wires being encased in lead pipe, with an outer covering of tarred jute. The cables are simply laid in the ground, generally under the pavement, save in certain places across passages and roads, where small brick culverts are constructed as an additional means of protection for the mains from the heavy traffic.

Leeds.—The Corporation of Leeds own the gas works, and they supply gas to the public at the price of 1s. 10d. per 1,000ft. The Corporation of Leeds have been engaged in carrying out experimental works in electric lighting since May, 1883 (see *Electrician*).

Sheffield.—The Sheffield Telephone Exchange and Electric Light Company (Limited), with a capital of £60,000, has installed the only system of electric lighting in Sheffield, but without any special powers or authority to light the town. The Corporation did not oppose the company, or promote any scheme of electric lighting on its own behalf. The Thomson-Houston system is used for arc lights at high tension. There are three dynamos for producing a total of 150 arc lights, each of 2,000 candle-power, and each dynamo works up to 2,000 volts. These machines were made in America, and each of them requires 40 horse-power in the working. There is also a 700-light Mordey alternator, made by the Brush Electric Light Corporation. Orders have been received for all the lights that the present machinery can produce, and more appliances will be laid down forthwith. The engine is by Tasker, Sons, and Co., and has a Galloway boiler in connection with it. The charges are :—For one arc lamp £20 per annum (equal to a penny and a fraction per hour); two ditto, £35; three ditto, £50. Incandescent lamps, 23s. for each lamp of 16 candle-power, and the transformers for incandescent lighting are fixed on the consumer's premises. The works produce 150 arc lights of 2,000 candle-power nominal, with actual light of 1,000 candles through the opal globes. Incandescent lighting only admits of comparison with gas in regard to cost. The company in Sheffield asserts that it can manufacture and supply electric light with profits equal to what would be gained from gas at 4s. per 1,000ft. The company's undertaking in Sheffield yields a dividend of 7½ per cent. and, in addition, a large reserve fund has been created; but the company carries on a large telephone exchange business in addition to the electric light. The charges for gas in Sheffield are regulated according to scale—viz., 2s. 4d. per 1,000ft. to ordinary consumers, but for large supplies up to 500,000ft. 2s. 2d. per 1,000ft. is charged, and 2s. between 500,000ft. and 6,000,000ft., and 1s. 10d. per 1,000 cubic feet for any greater quantity. The price paid for public lighting by gas is 1s. 10d. per 1,000 cubic feet.

Eastbourne.—The electric light was introduced in September, 1882, by a local company, with a share capital paid up of £12,500, recently increased by some £5,000 Debenture Stock. The company began operations on the series system of lighting, but found it advisable to alter the works to the alternating or parallel transformer system instead. As a result, it is hoped that the company will be in a position to realise a profit, notwithstanding the increased price of coal from 19s. to 25s. 6d. per ton. The water for steam power costs the company 1s. per 1,000 gallons. The wires conveying the currents are all underground, and the public lighting system is entirely separate and apart from the private supply. In all there are 2,300 incandescent and 21 arc lights, for which the following charges are made :—Incandescent lights: 1s. per unit for first 100 hours in quarter; 8d. for second hundred hours; 4d. for any greater number. Arc lights—The Corporation pay the company £30 per annum for each arc light.

The company uses one compound engine (Fowler) of 200 horse-power, and two dynamos (Lowrie-Parker) with an output of 50 and 70 units respectively. This is sufficient to supply 2,000 16-candle-power lamps at one time. The steam for the engine is supplied from a tubular boiler of the locomotive type working at 140lb. pressure per square inch. The cables are $\frac{7}{16}$ths and are laid underground in 3in. gaspipes. The wires are enclosed in three layers of india-rubber, with an outer covering of stout braiding. The present price of Welsh coal in Eastbourne is 25s. 6d. per ton. Gas supplied to private consumers costs 3s. 7d. per 1,000 feet, and the charge for public lighting is at a somewhat lower rate.

Hastings.—Electric light has been installed by a company with a nominal capital of £50,000, of which about £14,000 is issued. The cost of production and supply is slightly in excess of gas, and the company, which pays a dividend of 3 per cent. on the undertaking, is now negotiating to transfer the work to the local authority.

The company supplies 1,000 incandescent lights to hotels and other places, of from 8 to 10 candle power each, and 30 Brush arc lights, each of 2,000 candles nominal. For the latter the company is paid £30 each per annum. There are 20 miles of underground wire in Hastings, the cables being $\frac{7}{16}$ strand, cased in gutta percha, with other material for outer covering. The factory and workshops, built at a cost of £4,000, are of three stories, the upper story being set apart for workmen's dwellings. The machinery includes five Brush dynamos; two 40 horse-power Robey boilers and engines, one of which is sufficient for the work, and one large multitubular steel boiler of 100 horse-power, by Duncan, Stewart, and Co., Glasgow.

The scale of charges for electric light in Hastings is as follows :—Cost of installation (not including brackets), one group of eight lamps. £5; each succeeding group, £4; supplying light from sunset to 11 p.m., £2 per lamp per annum; supplying light from sunset to 8 p.m., £1. 10s per lamp per annum. If supplied by company's meter, ½d. per lamp per hour: Installation for one arc lamp, £5; lighting for one arc lamp, £30 per annum. The company will lay mains to consumers' premises. Coal is brought to Hastings by rail from Yorkshire *vid* London, and costs 18s. 10d. per ton, with the addition of 2s. 6d. for town dues, making in all 21s. 4d. per ton. The charge for gas is 3s. 4d. per 1,000ft. The County Council of Hastings are under a contract with the company as to lighting the front line at £30 per light per annum for each arc lamp.

Rochester.—In Rochester electric lighting is carried on very successfully by a local company, which is working at the present time without statutory powers; but the necessary steps are now being taken to obtain a Provisional Order. The system employed is that of high-tension alternating currents, in conjunction with transformers.

The plant now at work is at present supplying what is equivalent to about 3,000 lamps of 10 candle-power each, but it is sufficient for 4,000 lamps of like power, and has cost £13,000, which includes three items of extraordinary expenditure, as follows :—1. £1,300 for sinking and boring an artesian well 339ft. deep, which affords a constant supply of water at the rate of 30,000 gallons per hour. The water is used for condensing and other purposes; great economy in working being thereby effected, as there is a saving in fuel to the extent of nearly 50 per cent. 2. £1,000 for engine and dynamo foundations, which had to be made in a very substantial manner. The station is erected in a very convenient situation on a wharf, on the River Medway, where coal, &c., are readily landed, but where the sub-soil to a depth of 50ft. consists of nothing but river mud, through which wooden piles had to be driven into the solid chalk below to support a solid block of concrete 18ft. in thickness. 3. £2,000 for lamps, wires, and other miscellaneous stores required for installing the light in public and private buildings, clubs, shops, dwelling-houses, &c., the company doing the whole of the fitting work themselves. The mains are carried overhead on poles, there being two circuits, each about two miles in length. At the present time the company have no portion of their plant in duplicate. The dynamo was supplied by Mr. S. Z. de Ferranti, of London, and is of the 1888 type: 150 estimated horse-power, and cost £1,050. The engine employed is of the horizontal type, surface condensing, 4ft. stroke; it is fitted with Corliss valve gear, and Knowle's patent supplementary governors. The driving-wheel is 20ft. in diameter, cotton ropes being employed for gearing. The engines were made and supplied by Messrs. Hick, Hargreaves, and Co., of Bolton. The Babcock and Wilcox Company, of London and Glasgow, supplied the boiler, which is of their well-known water tube pattern. Later on it is intended to employ the foregoing plant for day work only. Steps are already being taken for laying down plant four times the size of that already installed. The uniform charge for current supplied is 6d. per Board of Trade unit. The anticipated income for this year from the lamps at the present time supplied is £2,500, which is calculated to yield 11 per cent. dividend on the invested capital, after a liberal allowance for depreciation on plant has been made. It should, however, be borne in mind that working expenses are kept very low, one man alone, for example, attending to boiler, engine, and dynamo. The charge for gas at Rochester is 2s. 3d. per 1,000 cubic feet.

West Brompton.—This central electric lighting station, adjoining the West Brompton station of the Metropolitan District Railway, was opened on January 24, 1889, by the House-to-House Electric Light Supply Company (Limited), which has expended about £35,000 on plant and works, and expects to realise a substantial profit from the undertaking. The buildings are most admirably designed, and are constructed with a view of extension in the future. The plant installed is on the Lowrie-Hall system, and is divided into three units. Each unit consists of 150 estimated horse-power, each capable of producing electricity for 4,000 lights, and in order to always have a margin of power in case of break-down, the maximum work done by the station will be the supply of electricity for 8,000 incandescent lamps. In case, therefore, of any one unit having to stop when the full load is on, the remaining two will be able to easily carry on the work. In connection with this plant 12,000 lamps may freely be let out,

Digitized by Google

wiring in the houses on the circuit being done for this quantity, as in practice it is found that never more than two-thirds of the total number of lamps wired for are in use at one time.

While in London your committee inspected the works of Mr. Sebastian Ziani de Ferranti, at Charterhouse-square. Here the manufacture of all descriptions of electrical appliances—many the inventions of Mr. Ferranti—is in operation on an extensive scale. One dynamo working up to 2,400 volts, driven by an engine of 150 horse-power, was taken asunder, portion of the armature removed, replaced, and the machinery again put in motion in a few minutes. This rapid taking apart of the machine and the ease with which coils can be replaced are rightly considered by the inventor to be two of its most valuable features. A dynamo sufficient for 200 lights can be supplied for £85, but as the smallest size machine Mr. Ferranti stocks is for 3,000 lights, machines for a less number of lights would have to be specially made to order.

CORRESPONDENCE.

THE BEHAVIOUR OF FLAMES IN THE NEIGHBOURHOOD OF INFLUENCE MACHINES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Shelford-Bidwell, at the Physical Society, and yourself, in your editorial column, have made reference to the behaviour of flames in the neighbourhood of the electrostatic induction machine. Will you, therefore, permit me, on behalf of Sir Archibald Campbell, of Blythswood, and myself, to describe very briefly some observations which we made last March, but which we did not intend to publish until we were able to give results of further investigation of the subject.

I may say that Sir Archibald Campbell has constructed, at his laboratory at Blythswood, two Wimshurst machines of very great capacity. The second, indeed, is not complete: it is being built in sections, and when finished will give an enormous quantity of high potential electricity. Already a *current* of one or two milliamperes, at a potential of some thousands or hundreds of thousands of volts, can be obtained; and we have measured the current, under definite conditions, by electrolysis of acidulated water in capillary tubes, making use of a device of the late Prof. Andrews for the purpose.

When a common candle is brought near to one or other of the conductors of the machine, the flame is of course blown about by the air currents, which can be felt rushing off from any points of dust that may be sticking to the polished surface of the conductor. If the discharging rods are tipped with clean polished balls of, say, 2in. diameter, and a lighted wax vesta is held a little below the horizontal line joining the centre of the balls, the flame is pulled out on both sides, so as to look like an ordinary bat's-wing gas jet. If a lighted candle is brought near to the positive globe it is extinguished, the flame being driven about in a very curious way, which I will not attempt to describe just now. If, however, the flame is brought near to the negative globe it is not blown out; but, on the contrary, if the wick has a bright smoking spark at the top, the flame is *relighted* by the sparks which play down the smoke column on to the wick. The relighting cannot be done at the positive globe by any torrent of sparks, so far as we have seen.

A lighted spirit-lamp put on the positive conductor is extinguished almost as soon as the handle of the machine is turned. But if put on the negative conductor it is not easily extinguished. If, however, the machine is turned very rapidly the flame is blown out. This observation was made by Messrs. M. Maclean and Makita Goto in the course of experiments on electrification of the atmosphere by flame. The phenomenon seems to be a mixed one. The blowing out of the flame on the negative conductor when the machine is in very vigorous action depends, no doubt to some extent, on the air currents generated.

—Yours, &c., J. T. BOTTOMLEY.

December 14, 1889.

ELECTRIFYING STEAM.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: There seems to have been a little misunderstanding at the Physical Society last Saturday, judging from your report on Mr. Bidwell's Paper and its discussion.

Prof. Silvanus Thompson, who was kind enough to mention my work as bearing on the subject, is said to have suggested that Mr. Bidwell's observation of the increase in size of the globules was contrary to what had been noticed and described by Mr. Clark and myself (see *Nature*, July 26, 1883, xxviii., p. 297; *Phil. Mag.*, March, 1884; and *Proc.* Roy. Inst., May 28, 1886); but the fact is that it is essentially identical.

Electrifying a fog, whether a steam fog or any other fog, causes the small particles to coalesce into larger ones, and consequently to fall as rain or coarse mist.—Yours, &c.,

December 13, 1889. OLIVER J. LODGE.

[We rather understood Prof. Thompson's remarks to be directed to the contrast in time between the two phenomena: the instantaneous increase in the opacity of the steam jet, being contrasted with the comparatively slow clearing of the fog in Prof. Lodge's well-known experiment.—ED. *E.*]

DISC WINDING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the conclusion of Mr. A. T. Snell's article, "A Comparison between the Continental, American, and English Dynamo-Electric Machinery," which you published last week, there is a diagram (Fig. 26, p. 140) which is given as illustrating the "New Edison Disc Winding," and is referred to in the text as having been patented in 1887. I wish to point out that the method of disc winding illustrated in the diagram referred to, is described in my patent, No. 717, dated January 17, 1887, Disc-Dynamo-Electric Machines and Motors.—Yours, &c.,

W. B. SAYERS.

24, Glycena-road, Lavender-hill, London, S.W.,
December 17, 1889.

THE ELECTRIC LIGHT AT TEMESVAR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: We notice in your issue of the 6th inst. a communication from your Vienna correspondent, in which a case of fire due to electricity is reported from Temesvar. As the information is evidently taken from the grossly exaggerated reports which found their way into some of the daily papers, we ask to be allowed to correct these statements.

Owing to a piece of lead-covered cable fixed against a brick wall in a court-yard being injured, a short circuit lasting only some few seconds occurred. There was no casing to catch fire, the fire brigade did not extinguish the flames, nor was the town in any degree alarmed. In proof of this we may mention that the general public knew nothing of the matter, and every one was astonished at the reports published in the Vienna papers —sent in, no doubt, by some reporter in want of sensational matter.

Asking you to kindly find space for the above, we remain,

Yours, &c., F. W. CLEMENTS,
General Representative for Hungary of the Brush Electrical Engineering Company.

Temesvar, Coronini-Platz, December 11, 1889.

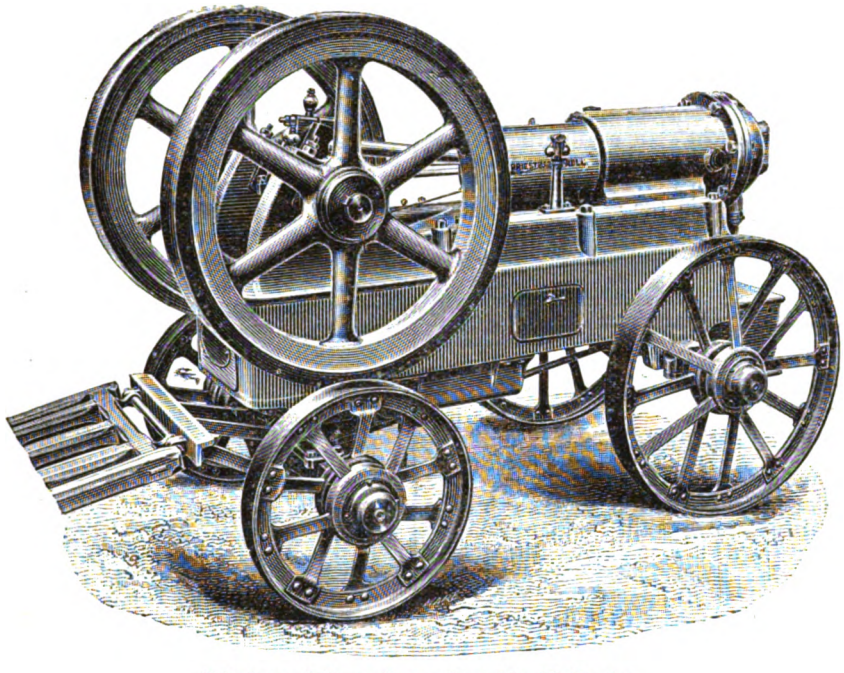
THE PRIESTMAN OIL ENGINE.

Since its first introduction, some few years ago, the Priestman engine has been considerable improved, and, as a consequence, it is now steadily making its way. The uses to which a reliable portable engine, requiring little attention and few repairs can be put, are so numerous that it is not surprising to find an engine like the Priestman which fulfils these requirements to so large a degree, should be in great demand For driving dynamos in connection with installations in country houses, a good oil engine is especially useful.

One special feature of this engine is that it uses the common petroleum oil of commerce and not petroleum spirit, which has a very low flashing point. The general arrangement of the engine is similar to a gas engine, the cycle being the same as that of the "Otto." The power is obtained by forcing the oil, which is contained in a small tank, by means of air pressure into a vaporiser, where it becomes mixed with the requisite quantity of air to form a combustible charge, which, being heated, passes into the cylinder,

Digitized by Google

Here it is at first compressed and then fired by an electric spark. The exhaust passes away round the vaporiser and forms the heating power for the incoming charge, and thence passes into the open air through an exhaust pipe. The engine requires little or no attention after starting, and can be safely left to run on by itself. The cost of working is small and no driver is required. By recent improvements in the engine, the oil consumed has been as low as 1·2 pints per actual horse-power per hour, which at the present cost of oil is less than 1d. per actual horse-power per hour. No lubricating material is required for the cylinder, as the charge itself does all that is necessary in this way. The most general form of the engine is the ordinary horizontal type, two forms of which are supplied—one being the engine itself mounted upon a substantial pole plate and having a separate tank for circulating water, the other form consisting of the engine mounted upon a substantial cast-iron tank or water vessel, which in itself forms a massive foundation. In addition to the horizontal types, a portable engine (*see* Figure) has lately been introduced, and at the present time the construction of both launch and tramcar engines is under consideration. Many minor improvements have lately been made in the construction and working of these engines, more particularly so as to ensure economical and reliable working, and to still further simplify the attention necessary. A new form of electrical battery has been added, which is an ordinary storage cell which will last for from two to three months working daily, and is easily re-charged.



Triestman 6 Horse-Power Portable Oil Engine.

As an additional proof of the value of this engine we have only to add that it secured the silver medal of the Royal Agricultural Society at Nottingham last year.

LEGAL INTELLIGENCE.

United Telephone Company v. Tasker.

Mr. RENSHAW, Q.C., moved, before Mr. Justice Kay, on Friday last, to dismiss the action of the United Telephone Company *v.* Tasker for want of prosecution, on the ground that the plaintiffs had failed to comply with an order for a further and better answer to the interrogatories administered by the defendants. He said the action was brought to restrain an alleged infringement of the Bell Telephone Patent, and the defendants put in a defence and counterclaim for damages, on the ground that the plaintiffs, having made an agreement with the defendants as to supplying them with telephones for the purpose of a telephone exchange at Sheffield, afterwards promoted by a rival company, the National Telephone Company, the setting up of a rival exchange in the same town. In connection with this matter interrogatories were administered, the answers to which had been decided to be insufficient, and on November 20th an order was made that the plaintiffs put in a further and better answer within 14 days. A further affidavit was filed on December 4th, but this, he contended, was also insufficient, and he, therefore, brought the present motion ; the real object of which, of course, was not to have the action dismissed, but to have a full and sufficient answer.

Mr. BOUSFIELD having also pointed out the insufficiency of the answer, and urged that the defendants were entitled to bring this motion under Order 21,

Mr. MICKLEHAM, for the plaintiffs, contended that the answer was sufficient.

Mr. JUSTICE KAY decided that the answer was not sufficient ; at the same time he exceedingly disapproved of the method which had been adopted for bringing the question before the court by way of motion, instead of taking out another summons for a better answer. He should, therefore, order a further and better answer within a week, but should not give the applicants their costs.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning.*]

Appointments Vacant.—The London County Council advertise for an inspector to test electric lines, certify meters, &c. The salary is £200 per annum ; an assistant-inspector is also required, at a salary of £2 per week. An inspector is also advertised for, whose duties will be to supervise the work of the electric light companies in the public thoroughfares, the salary being £3. 3s. per week. Applications are to be sent in by January 7th next. Full particulars are given on p. XIII. of advertisements.

——— The Metropolitan Asylums Board require an engine-driver to attend to the electric light installations on board the hospital ships lying in the Thames at Long Reach, near Dartford. Applications to be in by December 23rd. Further particulars will be found on p. XIII. of advertisements.

Admiralty Contract.—Messr. Humphrys, Tennant, and Co. have recently supplied new machinery for several vessels under construction, which includes engines, &c., for the electric light.

Tender Accepted.—The tender of Mr. F. A. Harper, of Balinasloe, has been accepted for putting up electric bells and batteries at the District Asylum, Balinasloe, Ireland.

Personal.—Mr. J. D. F. Andrews has, we are informed, withdrawn from the firm of Messrs. Muir, Mavor, and Coulson, of Glasgow, and has set up as a consulting electrical engineer, at Botolph House, Eastcheap.

Glass Globes for Electric Lighting.—We have received from Messrs. A. and R. Cochran their illustrated catalogue of new designs in glass globes and shades for electric lighting. Some of these designs are very artistic and elegant, and we would specially commend Nos. 3,080, 3,082, 3,088, 3,093, 3,127, 3,244, 3,261, 3,346 3,384, and 3,385.

——— We have also received from Mr. Carl Quitmann a sheet of designs of globes and shades. The sheet also includes diagrams of incandescent bulbs, bushes, insulators, &c.

Digitized by Google

THE ACME ELECTRIC WORKS.—This Company have recently taken offices at 17, Princes-street, Hanover-square, London, W., where a stock of their specialities will be kept. The works remain at Ferdinand-street, Chalk Farm-road, N.W.

THE PHONOGRAPH AND THE TYPEWRITER.—An interesting demonstration of the use to which the phonograph can be applied was given on Saturday last to a number of representatives of the press, at the offices of Messrs. J. and W. Richardson, 12, Queen Victoria-street, E.C. Messrs. Richardson are the proprietors of the Bar-lock typewriter, and it was in conjunction with this that the phonograph was used. The "typist" sat at his instrument, and on his left was placed a phonograph, worked by a small electric motor, a stout cord and treadle being used to stop or start the cylinder of the phonograph when necessary. A cylinder being put into position, the "typist" placed the pair of tubes to his ears, and proceeded to reproduce the messages or letters which had been previously spoken thereon. As the speed of the cylinder can be easily regulated, or stopped, or put back, the operator experienced no difficulty in following the message, the result being that a faithful copy of the record on the cylinder was taken. It is unnecessary to point out to business men the far-reaching possibilities of such a combination. The representatives present expressed their admiration at the improvements made in the phonograph, and not a little praise was bestowed upon the compact electric motor used. Colonel Gouraud is at present in America, but his representative was present, and informed us that, simple as it all was, he was instructed to say that the more perfect instrument which Mr. Edison has now completed, and which will shortly be introduced, will render the combination still more effective and popular. While upon the subject of typewriters, we may mention that recent improvements made in the Bar-lock Typewriter include an arrangement by which the reversing of the inked ribbon is automatically effected, and a pointer enables columns of figures to be easily written in exact alignment. In engineering offices this improvement will be fully appreciated. The type-written matter is also now in full view of the operator. A further advance has been made by Messrs. Richardson, in the discovery of an ink which will dry rapidly enough to admit of thousands of copies being taken off a typewriter letter and folded and enveloped at once.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

November 21, 1889.

18,604. J. PERRY, C. E. HOLLAND, and H. B. BOURNE. Hampstead. The measurement of and regulation by electric currents.

18,608. J. W. HARTLEY. Stoke-on-Trent. Compensator for signal wires.

18,638. A. DICKINSON. Birmingham. Improvements in the mode of driving electrical vehicles.

18,651. J. A. MCMULLEN. London. A system of conducting and distributing at a distance electric currents of large quantity from a low pressure continuous current generator.

18,654. R. H. GOULD and E. UBRIG. London. An automatic electrical device for signalling changes of temperature.

November 22, 1889.

18,700. T. W. WATSON and A. H. WATSON. London. Improvements in connection with electric battery cells.

18,712. J. B. VERITY and J. C. GIRDLESTONE. London. An improved form of connection for electric lamps for stage battens, footlights, &c.

18,740. F. KING. London. Improvements in couplings or clutches, more especially applicable to the driving of dynamo-electric machines connected in parallel.

18,743. S. PITT. London. Improvements in cables containing electric conductors (A. Day, United States).

18,755. A. RECKENZAUN. London. Improvements in the manufacture of plates for use in secondary batteries or electric accumulators.

November 23, 1889.

18,768. M. IMMISCH. London. Improved arrangement for applying electro-motors to vehicles and for transmitting motion to the axles thereof.

18,779. J. BERESFORD. Manchester. Improvements in material for making wire fencing, applicable also to the manufacture of telegraph wire.

18,795. W. P. THOMPSON. Liverpool. Improvements in or relating to dynamo-electric generators (The Westinghouse Electric Company, United States).

18,817. H. BIRKBECK. London. Improvements in electric mechanism for operating telephone call-bells and annunciators (F. W. A. Schneider and W. C. Keidler, Canada).

18,821. G. GAERTNER. London. Improvements in electric baths or apparatus for applying electricity for medical or other similar purposes.

November 25, 1889.

18,855. F. W. WHITE. London. An automatic attachment for electrical switches, gas and other taps or cocks, valves, &c.

18,897. J. G. S. CUNNINGTON. London. An improved quick-make and quick-break switch for electrical purposes.

18,908. W. C. JOHNSON and S. E. PHILLIPS. Improvements in switches for electrical circuits.

November 26, 1889.

18,939. H. P. HOLT. Manchester. Improvements in and connected with railway and tramway vehicles, and with their propulsion by means of electricity.

18,952. W. HOWSON. Sheffield. Improvements in electrical and automatic appliances and methods for manipulating aeronautic balloon batteries in conjunction with aerostatic, indicating, fulminating, and fumigating repeating magazine batteries, and in shells for same for the purposes of warfare.

18,953. G. MACAULAY-CRUIKSHANK. Glasgow. An improved electrode for secondary batteries of accumulators (W. A. Johnson and J. N. Smith, Canada).

18,966. O. A. ENHOLN. London. Improvements in primary or galvanic batteries.

18,979. W. R. MICHL. London. Improved regulator for electric currents

18,980. W. F. BRADNER. London. Improved means of suspending electric lamps and other suspended objects.

18,989. W. F. SMITH. London. Improvements in secondary or storage batteries.

18,997. A. J. BOULT. London. Improvements in or relating to the connecting of an accumulator battery in alternating current circuit (A. Foeppl, Germany).

19,004. W. WHITE. London. Improvements in suspenders and holders for electric glow lamps.

19,011. J. HOPKINSON. London. Improvements in dynamo-electric machines.

November 27, 1889.

19,079. F. BRYAN. London. Improvements in electrical instruments.

19,080. H. T. CHESWRIGHT. London. An improved construction of plates for secondary or other voltaic batteries.

19,081. R. WREDEN. London. Microtelephonic apparatus for divers.

November 28, 1889.

19,108. W. H. DOUGLAS. Birmingham. An improved instrument for registering electrical currents.

19,129. C. R. BONNE. London. Improvements in electric dry batteries (H. Meinecke, Junr., Germany).

19,142. J. HOPKINSON. London. Improvements in continuous-current transformers of electrical power.

19,155. R. KENNEDY. Glasgow. Improvements in and relating to electro-motors.

November 29, 1889.

19,190. E. L. LOVELL and A. F. LLOYD. London. Improvements in and relating to induction coils and other electro-magnets.

19,195. R. SUMMERS. London. Improvements in and relating to the laying of electric and other wires in streets and roads.

19,199. H. BADCOCK, W. GRUNSELL, and A. WALKER. London. Improved means for the prevention of polarisation in electric batteries.

19,216. F. J. PATTEN. London. Improvements relating to the generation, distribution, and utilisation of electrical currents.

19,220. SIEMENS BROS. AND CO. (Limited). London. Improvements in distributing electricity with alternating currents and apparatus therefor (A. M. Taylor, India).

November 30, 1889.

19,277. L. E. S. CHURCHILL. London. A new or improved apparatus for measuring, indicating, and recording electric currents.

19,283. L. B. MILLER. London. Improvements in apparatus for measuring electricity.

19,285. J. CAMPBELL. Glasgow. New or improved ship's electrical signalling apparatus.

December 2, 1889.

19,304. W. B. SAYERS. London. Improvements in electric motors and dynamo-electric machines.

19,335. J. C. MERRYWEATHER. London. Improvements in voltaic batteries.

19,354. H. LUBINER. London. Improvements in and relating to relays for telegraphic purposes.

December 3, 1889.

19,379. B. M. DRAKE, J. M. GORHAM, and E. ATKINS. Westminster. Improvements in electric switches.

19,389. W. H. WILLATT. Hull. Combined electrical steering and rudder indicating apparatus.

19,409. E. MANVILLE and W. L. MADGEN. Electrical pipe-lighter and advertising device.

19,554. M. VON DOLIVO-DOBROWOLSKY and the COMPANY ALLGEMEINE ELECTRICITÄTS-GESELLSCHAFT. London. Improvements in the connections of alternating-current generators and electric motors.

19,578. G. S. HILLE. London. Improved insulating material for electrical conductors.

December 7, 1889.

19,692. G. A. NUSSBAUM. London. Improvements in poles or supports for electrical conductors and similar purposes (N. O. André, France).

Digitized by Google

19,420. H. H. Lake. London. Improvements in alternating-current electro-magnetic motors (N. Tesla, United States).
19,433. F. Zöpke. London. Improvements in conduits or casings for subterranean electric lines.
19,450. M. Leblanc. London. An electro-motor worked by alternating currents.

December 4, 1889.

19,453. W. S. Boult. Birkenhead. Improvements in or relating to the construction and arrangement of machinery and apparatus for the installation of an electric accumulator.
19,484. F. V. Andersen. London. Improvements in electrical switches, specially applicable for electric vehicles fitted with two motors.
19,491. G. Phillippart. London. Improvements in electric batteries.
19,495. T. B. Grant. London. An improvement in arc electric lamps.
19,497. H. J. Dowsing and J. Appleton. London. An improved electric meter.

December 5, 1889.

19,525. W. H. Scott and Laurence (Paris and Scott, Limited). Norwich. Improvements in electricity meters.
19,529. E. Holt. Manchester. Improvements in current collectors for electric dynamo and other machines.

SPECIFICATIONS PUBLISHED.

1888.

16,623. Laurence, Paris, and Scott (Limited) and Another. Electricity meters. (Price 8d.)
16,946. Johnson (Mace). Incandescent electric lamps. (Price 8d.)
18,319. Boult. Suspenders for electric lamps and shades. (Price 8d.)
18,858. Brougham (La Société Perreur-Lloyd et Fils). Electro-chemical generators. (Price 8d.)
13,968. Zalinski and Smith. Electric primers for mines, &c. (Price 8d.)

1889.

282. Coates. Conduits for electric mains. (Price 6d.)
342. Mordey. Dynamo-electric machines. (Price 4d.)
614. Naylor and Naylor. Electric locking switch. (Price 8d.)
765. Abel (Siemens and Halske). Type-printing telegraph apparatus. (Price 8d.)
1,460. Sellon. Secondary battery plates. (Price 6d.)
1,537. Boult (Doubrava). Electric lighting. (Price 8d.)
9,977. Thompson (Marvin). Giving motion to percussive tools by electricity. (Price 6d.)
13,800. Heyl. Secondary batteries. (Price 6d).
14,232. Allison. Dynamo-electric machines. (Price 8d.)
15,377. Peck. Electric machines. (Price 8d.)
15,721. Groswith. Electric motors. (Price 8d.)
15,775. Winkler. Electro-dynamo machines. (Price 8d.)
15,821. Currie. Secondary batteries. (Price 8d.)
16,144. Hayman. Electric tell-tale apparatus. (Price 8d.)
16,231. Pfannkuche. Dynamo-electric generators. (Price 11d.)

COMPANIES' MEETINGS & REPORTS.

The Gülcher (New) Electric Light and Power Company (Limited).

The second ordinary general meeting of this Company was held at Winchester House, Old Broad-street, on Wednesday, Mr. D. de Castro presiding.

The meeting was a private one, but we have received from the Company the following abstract of the report of proceedings :—

The SECRETARY (Mr. T. C. Morgan) having read the notice calling the meeting,

The CHAIRMAN said that he thought it might be convenient before discussing the accounts to remind the shareholders of what had taken place during the last two years. In January, 1888, the Court of Chancery sanctioned a reconstruction of the Gülcher Company, and on February 23rd an agreement was signed for the sale to the new Company of the old Company's assets for £16,000 in cash and £20,000 in Deferred shares. On February 28th the first prospectus of the new Company was issued. Under that prospectus they attempted to raise £25,000 in Preference shares, out of which they would have had to pay the £16,000 in cash, leaving £9,000 for working capital. That attempt failed. They obtained only £12,000 of subscribed capital, which was largely taken by old creditors under the advice of their friend Mr. Howard Lane, who represented the creditors of the old Company, and whom they could not thank too much for the assistance he rendered in reconstructing it. Matters now remained at a standstill, and no move was made until May, 1888, when a new personage appeared on the scene. That gentleman thought that as they had got such a substantial sum as £12,000 absolutely subscribed, there ought to be some mode of raising the balance and of saving the assets of the Company ; and he suggested that if those who had subscribed the £12,000 were prepared to allow £8,000 of Debenture stock to take precedence of their capital, the Company might issue £8,000 Debenture stock and £12,000 of Preference shares, and so pay the £16,000. He also offered to find £5,000 of that Debenture stock if the scheme were undertaken. Thereupon the Directors of the old company raised £3,000 of the Debenture stock, and on June 10th a prospectus was sent out supported by another circular from Mr. Lane and Mr. Binswanger, urging the carrying out of the new scheme. At the end of July the whole of the £12,000, besides the £3,000 above mentioned, having been subscribed, a special resolution was passed on August 9th, to enable them to issue Debenture stock, a power which they did not then possess. That resolution having been formally registered, the assets of the old Company were on August 31st handed over to the new Company, and on September 1, 1888, the new Company started on its present career. He might tell them that of the £5,000 promised as above, only £500 was ever forthcoming, but in November, 1888, to make a long story short, the deficiency of £4,500 was, with the assistance of Major Cotton and Mr. Wallace, old Directors, found by the Board, thus overcoming their first serious difficulty.

The CHAIRMAN then proceeded to deal with the history of a contract entered into with the Corporation of Wellington, New Zealand, for the lighting of that town, which cost the Company a great deal more than their late manager had estimated. To carry out this contract the Directors invited the shareholders to find £10,000 on Second Debentures. Only £4,500 was at first subscribed, but eventually the balance was obtained, mainly from the Board, and by that means the Wellington contract was completed last September, and was now an income-producing asset. It was by the light of these and other difficulties, which he detailed, that the Directors asked the shareholders to read the accounts submitted, which only brought them down to a date when the New Zealand contract was still incomplete. Under a new *régime* matters had improved greatly, and so far as it was possible for a manufacturing company to say that it had made a profit without taking stock, he believed he might say that Mr. Fricker (the present general manager) had made a manufacturing profit of £2,500 during the last six months. That, if maintained, would be enough to pay the interest on all the Debentures, to pay their working expenses, and leave a dividend on their Preference shares. He explained that the present meeting had been postponed in the hope that certain negotiations which were pending, and which he trusted would turn out for the benefit of the Company, would have been by this time concluded, and he had been anxious to announce their completion at this general meeting. Those negotiations, however, had not yet been concluded, and as the meeting could not be legally postponed any longer, he could say no more than that he hoped to be able to announce the completion of them shortly. In conclusion, he appealed to the shareholders to stand by the Directors. There was a great future for electricity. The times were with them, and he believed they had lived into an era which would be as epoch-making as those which saw the introduction of printing and the utilisation of steam. He then proceeded to analyse the balance-sheet in detail, as well as the profit and loss account, and concluded by formally moving their adoption.

Mr. GOOLDEN seconded the motion. After some discussion of the accounts and the general policy of the Company, the motion was unanimously adopted.

The Directors having retired, resolutions were passed re-electing them all, and re-appointing Mr. Russell Day to be the Company's Auditor.

A vote of thanks was then passed to the Chairman, and the proceedings terminated.

The Maxim-Weston Electric Company (Limited).

The statutory general meeting of this Company was held on Wednesday, at the Cannon-street Hotel, Mr. John Marks having been voted to the chair.

The SECRETARY (Mr. Boyce) read the notice convening the meeting, together with the report of the liquidators appointed to wind up the old Company, an abstract of which is given below.

The CHAIRMAN then said that the only question of interest beyond what was stated in the report, and upon which he would have liked to say something to the meeting, was one as to which his mouth was necessarily closed, namely, the litigation now going on between Mr. Hugh Watt and the Company on the one hand, and between the liquidators and Mr. Watt on the other hand. It would be seen from the report just read that the liquidators had been successful in disputing Mr. Watt's claim to 7,376 shares in the old Company, for which Mr. Watt maintained that he held the certificates. But other shareholders held certificates for some of the same shares, and the liquidators contended that he was entitled to some 3,000 shares less than the number claimed. He (the Chairman) was happy to say that they had succeeded in upholding their contention before the arbitrator (Mr. Frederick Whinney), to whom the matter was referred. The present was merely a formal meeting to comply with the statute. Had the litigation now going on been settled, they would have long since wound up the Company, and there would have been no need to call them together on that occasion ; but as the litigation was not closed, the liquidators were bound to convene a meeting within twelve months after the passing of the resolutions to wind up the Company to report what they had done up to date. He concluded by moving the adoption of the report.

Sir HENRY HOARE asked what money they had in hand, and what work in the way of electric lighting they were doing.

The CHAIRMAN said that the question asked had reference to the new Company only, and did not bear upon the liquidation. He had no doubt, however, that Mr. Godding, the Chairman of the new Company, who was present, would, at the conclusion of the meeting, give any information with reference to the new Company. In further reply to a shareholder, he added that what Mr. Watt was entitled to was 4,416 shares at 1s. 6d., instead of 7,376, but no money would be paid until the litigation now pending was settled.

The report was then adopted.

Mr. JOHN NEWTON proposed, and a Shareholder seconded, a motion to the effect that the report of the liquidators should be printed and circulated among the shareholders of the old Company.

Digitized by Google

Sir HENRY HOARE thought that they should be satisfied with the succinct and reasonable report presented to the meeting, and save themselves the expense of its circulation. He concluded by moving an amendment to that effect.

Mr. NEWTON: How many shareholders are there?

The SECRETARY: 1,720.

Mr. J. JOSEPH seconded the amendment, which on being put to the meeting was lost. The original resolution was then put and carried.

A long discussion followed on the subject of remunerating the liquidators, and eventually, on the motion of Sir HENRY HOARE, seconded by Mr. NEWTON, it was unanimously resolved to grant them 150 guineas on account out of the money at present in the coffers of the Company, pending the conclusion of the litigation referred to, and the winding up of the company.

The CHAIRMAN, as one of the liquidators, returned thanks, remarking that the work imposed upon them had been so onerous that he, for one, if he could have foreseen what was in store for him, would have been exceedingly reluctant to undertake the duties. They would complete the liquidation as speedily as possible after the conclusion of the litigation.

ABSTRACT OF REPORT OF THE LIQUIDATORS.

By special resolution the liquidators were authorised to enter into an agreement with a new Company, to be named the Maxim-Weston Electric Company (Limited), for the sale to such new Company of the business and property of the old Company. The new Company was registered January 17, 1889, and the liquidators have entered into the agreement with the new Company which was sanctioned by the shareholders of the old Company. In pursuance of that agreement, the new Company has taken possession of the business and property of the old Company, with the exception of certain claims to be hereafter referred to.

The new Company have paid debts and liabilities of the old Company, and of the liquidators, amounting to £4,180. 14s.

The new Company have allotted to shareholders in the old Company 262,536 shares of 3s. each in the new Company, with 2s. each credited as paid thereon in exchange for shares of the old Company.

Proceedings were taken in the Chancery Division to restrain the liquidators from carrying the agreement into effect. These proceedings were compromised. Arbitration proceedings were afterwards instituted. Ultimately the liquidators arranged to pay to the dissentient shareholders 1s. 6d. per share, and the new Company have paid on this account the sum of £1,813. 14s. 6d.

Of the 312,000 shares to be allotted to the liquidators or their nominees by the new Company 49,464 shares were not applied for by the shareholders of the old Company. Of these shares 11,845 have been sold by the liquidators, and have realised the sum of £868. 17s. 6d.

With reference to a dispute between the liquidators and Mr. Hugh Watt as to the number of shares in the old company to which he was entitled, such dispute was referred to arbitration by Mr. Whinney, who decided that Mr. Watt was entitled to 4,416 shares in the old Company, and that he would be beneficially entitled to a further 2,710 shares if he paid the sum of 5s. per share. Further, that Mr. Watt pay to the liquidators the sum of £50 towards their costs of the reference.

The liquidators regret to state that of the £9,769. 19s. 9d. appearing at the date of the liquidation as book debts, and which were nearly all included as good book debts in the 1887 balance-sheet, they have only been successful in recovering £1,143. 5s. 3d. This is owing to the fact that many of the accounts were disputed, and a very much smaller sum than that stated in the Company's books had to be accepted in order to effect any settlement.

As litigation is still pending with Mr. Watt, the liquidators refrain from further comment upon them.

Metropolitan Electric Supply Company (Limited).

The following is the report of the Directors of this Company, to be presented to the second ordinary general meeting of shareholders, to be held at Winchester House, Old Broad-street, E.C., to-morrow (Friday) at 12 noon. A full report of the proceedings will appear in our next issue:—

1. The Directors have satisfaction in submitting the statement of accounts to September 30, 1889, and in informing the shareholders of the progress made by the Company.

2. Since the last general meeting important rights have been granted to the Company, with the sanction of the Board of Trade, and confirmed by Parliament. Extensive installation works have been completed, and are now supplying the electric light, and other works of the same character are in progress, and approach completion, for the efficient lighting of the areas assigned to the Company. These areas are estimated to include in the aggregate about 35 miles of streets, a large number of which run through some of the wealthiest portions of the metropolis.

3. The existing demand for the electric light far exceeds the Company's power of supply, even if its authorised capital had been all called up and expended on installation works, and the Directors have under their consideration the issue of debentures at a moderate rate of interest, so as to avoid increasing the share capital at present. If, however, the anticipations of the Directors are realised, there seems little doubt that the share capital of the Company will have to be considerably augmented. The Chairman, in the evidence he gave before the Board of Trade inquiry, stated that, if the Company were as successful as he expected, its share capital of £500,000 would have to be increased four-fold, and the present prospects of the Company, judging from the actual applications for the light recorded in its books, point to this estimate being verified, and to a highly-satisfactory dividend being earned.

4. The largest item of capital expenditure is that incurred upon the erection of the stations which are described in paragraph 10.

5. Since the last general meeting, the Board of Trade, acting under the powers conferred upon that department by the Electric Lighting Acts, have held an official inquiry into the applications by this and other companies for Provisional Orders and licences. This inquiry lasted through the month of April, and resulted in a valuable report by Major Marindin, the Board of Trade Inspector, wherein he recommended that there should be allotted to this Company the following areas:—

Under the Mid-London Order.—The whole of the areas comprised in St. Giles-in-the-Fields; St. George, Bloomsbury; St. Andrew, Holborn-above-Bars; St. George-the-Martyr; St. Sepulchre, Saffron-hill; Hatton-garden; Ely-rents and Ely-place; the Liberty of Glasshouse-yard; St. Anne, Soho; St. Paul, Covent-garden; St. John the Baptist; Savoy, or Precinct of Savoy; St. Mary-le-Strand; St. Clement-Danes and the Liberty of the Rolls; together with the extra-parochial places known as the Charter House, Gray's-inn, Lincoln's-inn, Staple-inn, and Furnival's-inn.

Under the West London Order.—The whole of the parish of St. Marylebone.

Under the South London Order.—The whole of the parishes of St. Mary Lambeth; St. Leonard, Streatham; and Clapham.

Under the Bill.—A portion of the parish of St. Martin-in-the-Fields.

The Directors decided not to proceed with the South London Order, but propose making a fresh application for it, when they hope to make satisfactory arrangements with the local authorities with whom they were not able to settle terms within the time at their disposal.

A larger portion of St. Martin-in-the-Fields than that recommended was afterwards conceded. The remaining Orders were confirmed by Parliament during the last Session.

6. The result of this legislation has been to give the Company the right of supplying electricity within the above-named areas, and if the Board of

PATENT
SILICIUM BRONZE AND SILICIUM COPPER WIRE.
The best for overhead Telephone and Telegraph Lines,
AND ALL ELECTRICAL PURPOSES.
Hard Drawn High Conductivity Copper Wire.
ROLLED AND DRAWN
PHOSPHOR BRONZE.
PHOSPHOR BRONZE
PHOSPHOR BRONZE
VULCAN PHOSPHOR
DURO METAL
PHOSPHOR BRONZE
BEARINGS, BUSHES,
AND OTHER PARTS OF
ELECTRICAL MACHINERY.
SOLE PROPRIETORS of the British, Indian and Colonial Patents,
THE PHOSPHOR BRONZE COMPANY (Limited),
87, Sumner Street, Southwark, London, S.E.
WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

Digitized by Google

Trade, to avoid the frequent breaking up of streets and interference with traffic, adhere to the principle laid down, that not more than two companies shall be recommended for each district—one restricted to the use of the alternate-current transformer system, and the other to the use of the continuous-current system—future competition will be limited.

7. This principle, valuable in itself and of great service both to this Company and the public, could only be upheld after a full and exhaustive inquiry into the means of the various companies and their proposed methods of supply. This necessarily involved considerable delay and expense, both the London County Council and the local authorities taking part in the inquiry conducted by Major Marindin, and also in the subsequent proceedings before the Committees of both Houses of Parliament. The subject has been thus thoroughly thrashed out, and the large and important areas assigned to this Company will be supplied with the electric light under satisfactory conditions, which have, moreover, the advantage of both Departmental and Parliamentary sanction.

8. The Company is seeking powers to supply other areas of the metropolis, and has given the requisite notices to that effect.

9. It must be understood that the position of the Company with regard to its allotted areas has been only recently sufficiently assured to warrant the Directors in completing their system of supply. It was not until after the Royal Assent had been given to the Confirmatory Acts in August last that the Company was authorised to break up the streets for the purpose of laying underground mains. Notwithstanding this, it will be seen by the following list of central stations that good work has been done, and that the demands on the recently completed station at Sardinia-street are already so great as to necessitate a duplication of the existing plant.

10. CENTRAL STATIONS.—For supplying electricity in the Company's areas, the following stations have been erected, are in course of erection, or are about to be erected :—

(1) *Erected and Working.*—(*a*) Whitehall Station (continuous current).—This station is now about to be fully employed, the demands for current being in excess of its capacity, regard being had to the requirements of Whitehall-court when completed.

(*b*) Sardinia-street, Lincoln's Inn Fields (Alternate-Current Transformer).—This station commenced working on September 21st last. The demand for light being in excess of the present capacity, the Directors have lately decided to order the completion of the station, by which its power of supply will be more than doubled.

(*c*) Rathbone-place, Oxford-street (Alternate-Current Transformer).—A small station on this site was purchased in February last as a going concern. Arrangements were made for the erection of a larger plant, and a portion of the new machinery is now running. The full capacity of this station is also fully engaged.

(2) *In Course of Construction.*—(*d*) South Mews, Manchester-square, Marylebone (Alternate-Current Transformer).—A large station is in course of construction on this site, and will, it is expected, commence working next spring.

(*e*) Waterloo Wharf (Alternate-Current Transformer).—The machinery for this station is in a forward state, but the Directors have delayed erecting buildings owing to negotiations, which are not yet concluded, with the London County Council.

(3) *About to be Constructed.*—(*f*) A station within the Strand District (now being partially supplied from Sardinia-street).

And conditionally on the Company obtaining the powers for which they are seeking :—

(*g*) A station to supply the western portion of the City ; and

(*h*) A station to supply Paddington.

11. The auditors, Messrs. Deloitte, Dever, Griffiths, and Co., retire, and offer themselves for re-election.

NEW COMPANIES REGISTERED.

CAMBORNE GAS COMPANY.—This Company has been registered to supply gas, electricity, or any other illuminating agent, in and around Camborne, Cornwall, purchasing for that purpose the existing Camborne Gas Works at Tuckingmill, on the terms of an agreement of November 29, 1889, made with John Thomas, and unregistered. Capital £10,000, in £5 shares.

GAS CONSUMERS' PROTECTIVE ASSOCIATION (LIMITED).—This association was registered on the 11th inst., with a capital of £1,000, in £1 shares, whereof 20 are founders' shares, to protect consumers of gas, electric light, or power, or water against loss or damage in connection with the supply or consumption thereof. Solicitors, Messrs. Burn and Galloway, 50, Gresham-street.

HEATHLEY, JANISCH, AND CO. (LIMITED). — This Company was registered on the 14th inst., with a capital of £3,000, in £1 shares, to trade as chemists, druggists, and dealers in proprietary articles, and in all kinds of electrical and scientific apparatus. Solicitors, Messrs. Watson and Dendy, Newcastle-on-Tyne.

THE KELVINSIDE ELECTRICITY COMPANY.—This Company has been formed, with a capital of £10,000 in £1 shares, and has been incorporated for the purpose of supplying electricity in Kelvinside. The necessary application, notice of which has been given to the local authority, will be made for a Provisional Order under the Electric Lighting Acts, and should the Provisional Order be obtained from the Board of Trade, and confirmed by Parliament, it is proposed to at once provide and equip an electricity station for the supply of electricity to the district of Kelvinside.

THE NORTH AFRICAN GAS SYNDICATE (LIMITED).—This syndicate has been registered, with a capital of £30,000 in £1 shares, to carry on the business of a gas or electric light company in the towns of Algeria and other parts of Northern Africa.

TRUST AND LOAN COMPANY OF CHINA, JAPAN, AND THE STRAITS (LIMITED).—Amongst the various objects for which the Company is formed is "take over or otherwise acquire" securities of telegraph and similar undertakings in China, Japan, the Straits Settlements, or elsewhere.

CITY NOTES, &c.

EASTERN TELEGRAPH COMPANY (LIMITED).—This Company announces the payment on January 14th next of interest of 3s. per share, less income-tax, being at the rate of 6 per cent. per annum on the Preference shares of the Company, for the quarter ending December 31st, and the usual interim dividend of 2s. 6d. per share on the ordinary shares, free of income-tax, in respect of profits, for the quarter ended September 30th. The register of transfers will be closed from January 7th to 14th, both days inclusive.

EASTERN EXTENSION AUSTRALASIA AND CHINA TELEGRAPH COMPANY.—This Company announces that the coupon on their Five per Cent. Australasian Government Subsidy Debentures, due on January 1st next, will be paid on and after that date at Messrs. Barclay, Bevan, and Co.'s, 54, Lombard-street, E.C. Coupons must be left three clear days for examination.

ANGLO-PORTUGUESE TELEPHONE COMPANY.—Coupon No. 4 of this Company's Six per Cent. Debentures will be paid, less income-tax, by the Alliance Bank, Bartholomew-lane, on and after January 1st next.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended December 13th amounted to £5,605.

GREAT NORTHERN TELEGRAPH COMPANY.—A half-yearly interim dividend at the rate of 5 per cent. per annum on the shares of this Company will be paid by Messrs. Hambro and Son on January 1st.

MANITOBA ELECTRIC AND GAS LIGHT COMPANY.—Messrs. Robert A. MacLean and Co. announce that the coupons, due January 1 next, on the Six per Cant. First Mortgage Bonds of this Company will be payable by them on and after that date.

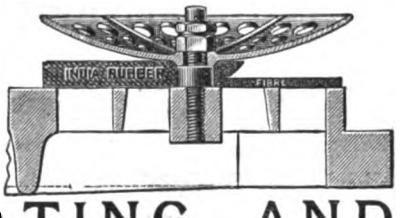
TELEPHONE COMPANY OF AUSTRIA.—Coupon No. 10 of this Company's Five per Cent. Debentures will be paid, less income-tax, by Messrs. Martin and Co., 68, Lombard-street, on and after the 31st instant.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended December 13th, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £4,017.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The receipts o this Company for the half-month ended December 15th amounted to £2,803, as compared with £2,836 in the corresponding period last year, a decrease of £33.

NEW VALVE

No Rubber, Percha, or Leather.



One-half the price of Rubber or Metal.

FOR CIRCULATING AND AIR PUMPS.

Unaffected by any Lubricating Oils. Does not Expand in diameter. Feed Water may be worked at any temperature Suitable for any shaped guards. Only one quality manufactured.

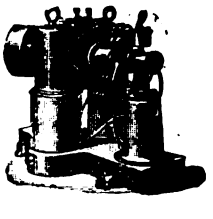
"12, John-street, Sunderland, 26th Sept 1888.
"DEAR SIRS,—In reply to your letter of the 25th inst., the Valves I got from you have done their work well, and ARE AN UNQUALIFIED SUCCESS. I lconti lc get them from you as required.—Yours faithfully, JAMES WESTOLL."

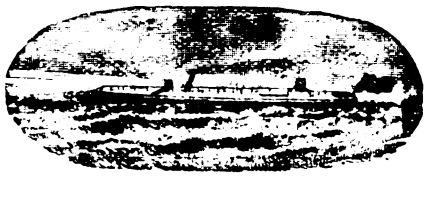
For further Testimony and Prices, apply to **MOSSES & MITCHELL, 68-71, Chiswell Street, London.**

Digitized by Google

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Wednesday, Dec. 18, 1889.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending Dec. 18, 1889.	
					£ s. d.		Highest.	Lowest.
			TELEGRAPHS.					
£								
1,770,360	Stock	12/6	Anglo-American	52 53	5 3 9	Jan., Apr., July, Oct.	52¼	...
2,614,820	Stock	25/0	Do. Preferred	87½ 88½	6 4 4	,, ,,	88½	87⅝
2,614,820	Stock	...	Do. Deferred	17 17½	...	February	17⅝	17⅜
130,000	£10	4/0	Brazilian Submarine	12½ 13	5 15 5	Mar., June, Oct., Dec.	12⅞	12⅛
112,900	£100	5%	Do. 5 per Cent. Bonds	102 104	4 16 2	January and July	...	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	106 109	4 11 9	June and December.	...	...
16,000	10	9/0	Cuba Submarine	14½ 15	6 0 0	February and August	...	...
6,000	10	10/0	Do. Preference 10%	19½ 20½	4 19 9	,, ,,	...	...
12,931	5	2/0	Direct Spanish (£4 paid)	¼ ½	4 8 11	March & September	...	...
6,000	5	5/0	Do. Preference 10%	9 10	5 0 0	April and October	...	...
60,710	20	3/6	Direct United States	10 10½	6 13 4	Jan., Apr., July, Oct.	10½	10¼
330,000	10	2/6	Eastern	14 14½	4 11 3	,, ,,	14⅛	13⅞
70,000	10	3/0	Do. 6 per Cent. Preference	15¼ 15½	3 16 2	,, ,,	15 9/16	15¼
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock	105 107	3 14 9	May and November.	107½	105
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	107 110	4 10 11	February & August	...	...
250,000	10	2/6	Eastern Extension	13¾ 14	4 12 10	Jan., Apr., July, Oct.	14	...
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	102 104	3 16 1	February & August	...	...
473,000	100	5%	Do. 5 per Ct. (Austrln. Gov. Sub.) Debs. 1900	103 106	4 14 4	January and July	...	...
179,177	10	2/0	Globe Telegraph and Trust	8⅝ 8⅞	5 3 9	Jan., Apr., July, Oct.	8⅞	8⅝
178,992	10	3/0	Do. 6 per Cent. Preference	14⅜ 14½	4 0 8	,, ,,	14⅞	14⅜
150,000	10	5/0	Great Northern	15¾ 16¼	4 12 4	Jan., July, and April	16⅜	16
17,000	25	12/6	Indo-European	41 43	5 16 3	April and October	...	...
9,000	8	4/0	Reuter's	7 7½	5 6 5	April and October	7 5/16	7¼
15,609	10	5/0	West African Telegraph	9½ 10⅜	...	...	...	...
300,000	100	5%	Do. 5 per Cent. Debentures	99 102	4 18 0	March & September	101½	...
30,000	10	5/0	West Coast of America	10¾ 11½	4 17 9	January and July	11⅛	11
150,000	100	8%	Do. Debentures 8%	123 128	6 5 0	June and December	...	...
88,321	10	nil.	West India and Panama	2⅞ 3⅛	...	...	3	2⅞
34,563	10	12/0	Do. 1st Preference 6%	11⅞ 12	...	April and October	11⅞	11¾
4,669	10	10/0	Do. 6 per Cent. 2nd Preference	14⅛ 15⅛	...	...	15½	15
45,181	15	6/0	Western Brazilian	9¾ 10¼	7 6 5	May & November	10⅛	9⅞
$1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	118 122	5 14 9	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	100 102	5 17 2	March & September	102	...
			TELEPHONES.					
224,850	14/0	5%	Consolidated Telephone and Maintenance	9/16 11/16	...	Yearly	...	...
220,000	£1	3%	Oriental (11s. paid)	3/16 7/16	3 15 11	...	...	...
*	*	...	National x d	5⅜ 5⅝	5 4 4	...	5 9/16	5⅜
55,000	5	3/0	United River Plate	4¾ 5¼	...	January and July	...	...
			ELECTRIC LIGHT.					
23,692	5	2/0	Anglo-American (fully paid)	...	...	February & August	...	...
79,934	5	6%	Swan United (£3. 10s. paid)	4⅜ 5¼	4 0 0	...	5 1/16	4⅞
500,000	10	...	Metropolitan Electric Supply (£3 paid)	4½ 5	...	...	5	4⅞
			MISCELLANEOUS.					
87,350	12	12/0	Telegraph Construction and Maintenance	44 45	5 0 6	March and July	44½	...
41,600	10	10/0	India Rubber, Gutta Percha & Telegraph Works	18 19	5 5 3	February & August	18⅝	18⅛





Before Ordering!

ELECTRICAL PLANT & ACCESSORIES

WRITE FOR THE FOLLOWING PAMPHLETS TO THE

UNITED ELECTRICAL ENGINEERING CO., Ltd.

Head Offices: 3, Princes Mansions, VICTORIA ST., WESTMINSTER.

"ELECTRICAL DISTRIBUTION."—Commercially considered, with Estimates.

"MACHINE DRIVING BY ELECTRICITY."—The Uses of Electro-Motors for Traction and Stationary Purposes.

"THE TELPHER SYSTEM OF CHEAP TRANSPORT," for Minerals, Goods and Passengers.

"ELECTRICAL SUPPLIES."—Prices and Particulars of the most approved Electrical Appliances

ELECTRICAL PLANT ON VIEW.

Digitized by Google

THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 606.—Vol. XXIV. FRIDAY, DECEMBER 27, 1889. Price Fourpence.

NOTES.

We have received the following important cablegram from our New York correspondent:—

> "It is cabled here that the London edition of the *New York Herald* says that New York is going to abandon electric lighting altogether and return to gas. Give this statement your strongest, most emphatic, and most unqualified denial. It is absolutely without truth. Electric lighting is gaining ground here faster than ever, and next year there will be at least 25 per cent. more electric lights in New York than now. Every large new building, without exception, is putting them in. As for the streets along which overhead arc wires have been cut down, many of the storekeepers are putting in their own arc lights, and there is already a marked reaction against the wire-cutting dictated by local political intrigues. The *New York Times* calls for a resumption of arc lighting, and the leading evening paper, the *Evening Post*, says no great city which has once been lighted by electricity will go back permanently to gas. The abolition of the New York Board of Electrical Control is called for even by papers that have been led to approve their crusade against overhead wires. Give the widest publicity to this contradiction of these malicious reports, which appear to electricians on this side of the water to be dictated by a mercenary purpose, and it is thought in some quarters that the opportunity has been seized by the gas interest to make a last desperate effort, for although the crusade was nominally begun against high-tension wires the axemen have even been cutting down circuits carrying only low-tension direct currents of 125 volts or less."

Our New York correspondent this week refers at considerable length to the question of the origin of the recent disastrous fire in Boston. The information contained in his cablegram of December 6th was sufficient to make the electric current theory appear more than doubtful, and his present letter ought to complete the process. It is, we hope, not too much to expect that after the conclusive manner in which electricity has been proved "not guilty" in this matter, fewer statements will be made at the meetings of local authorities to the effect that "the big fire at Boston, which was undoubtedly caused by electricity, renders it imperatively necessary," &c. &c.

Photo-electric and actino-electric methods of producing charges have claimed the attention of physicists from time to time. The researches of Becquerel on the currents produced by immersing in water two metal plates, one of which is then exposed to light, are well known. The experiments of Prof. Minchin about ten years ago will be within the memory of a number of our readers. Then about two years ago Hertz made the discovery that light falling upon a negatively electrified body causes a dissipation of the charge. This effect has been studied in greater detail by Wiedemann, Righi, and others. The latest researches on this head are by Prof. Stoletow (of St. Petersburg), an account of which we publish in another column, who has obtained some very striking results. He interposes in a circuit, with a galvanometer and a battery, an air condenser, consisting of two metal coatings, one of which is of sheet metal, the other of metallic gauze. If this condenser is so connected up that the gauze is positive and the plate negative, then, on illuminating the plate, through the gauze, by turning on an arc lamp, a current is obtained. The action is almost imperceptible, however, when the poles are interchanged. He proves that the effect is due to ultra-violet waves, and can be cut off by the interposition of sheets of glass, ice, or films of water.

In two recent issues of the *Electrical Review* of New York we find a proposed arrangement of an alternate-current generator and its circuits, which is described as a new three-wire system of distribution. It is due to Lieut. Patten, and it is claimed for it that it presents several features which enable effects to be obtained which usually accompany direct-current only, while at the same time it gives also the ordinary alternate-current effects. Briefly, it is proposed to commute the alternate current at the generator, and to send all the positive waves in one direction through a wire, M^1, all the negative waves through another wire, M^3, while a third or middle wire, M^2, is to act as a common return for both waves. It is suggested that direct-current apparatus may be placed in either the M^1 or the M^3 circuit, or that both these circuits may be included in the same direct-current apparatus—of course, the proper directions to give the same directive effect being observed; while alternate-current apparatus may be placed in the common return M^2. Without going into the details of the proposed arrangement of this system in connection with secondary batteries, electric motors, and arc lamps—which details show that the author of the scheme is not very familiar with the requirements of practical work with these apparatus—it will be evident that all the "direct current" effects aimed at could be much more simply obtained with two than with three wires. There is absolutely no advantage in the use of three wires in this way, so far as our reading of the proposal goes, while there is the great disadvantage that in either of the circuits M^1 or M^3 there is not only a discontinuous direct current, but the discontinuity amounts to having idle

Digitized by Google

ntervals between the successive waves equal in duration to the waves. In order to get even an approximately continuous direct current it would therefore be necessary to use both circuits in conjunction, and this only gives in a very roundabout way what would be obtained by using an ordinary commutator, as has often been proposed, and sending the alternate current after commutation through an ordinary single circuit.

It will be seen that this system affords no justification for one of the principal claims put forward on its behalf, namely, that it renders possible the use of all ordinary electro-magnetic devices by means of alternate currents without commutation. Many good things come to us from across the Atlantic, and for these we are thankful; but we must confess to a desire that it did not so often fall to our lot to have to criticise the immature, ill-considered, or impracticable schemes which so often appear in our American contemporaries, and we think it would be both in the interests of those journals and of the too-enthusiastic authors of some of these proposals if the matter were critically examined before being accorded the dignity of print; or, if there should be any insuperable difficulty in this course, that at least sufficient time should be allowed, before making announcements, to enable some practical trials to be made.

It would seem as if the Paris Municipal Council are not to be allowed any peace until the unfortunate Ferranti alternators at the Halles Centrales are ejected to make room for machines entirely French. At its last meeting the Council was induced to order the Commission Technique to immediately furnish a report as to its proceedings after the Council's resolution of December 31st last, relating to the use of foreign material. MM. Dandeu and Naze, whose 220-kilowatt alternator, it will be remembered, failed to find favour in the eyes of MM. Potier and Carpentier, who undertook to test it for the Municipal Council, are again to the front with a petition for a new trial. The Société Ferranti, in the vain hope of appeasing its enemies, has armed itself with a certificate setting forth that the alternators in dispute were actually built at the Cail works. In answer to this proof of the patriotic origin of the offending machines, our French contemporaries reply epigrammatically, but somewhat pointlessly, that "*Une bonne renommée vaut mieux qu'un certificat de vertu.*" It is evident that nothing short of the sacrifice of the Ferranti machines will restore the French electrical firms to their wonted equilibrium.

That strikes at the best are regretable incidents, and the present method of resorting to arbitration only under stress of circumstances is unsatisfactory, is, we believe, generally admitted. The efforts of the Council of the London Chamber of Commerce to devise a more civilised way of settling labour disputes are, therefore, worthy of every support. Appended to the Interim Report of the Labour Conciliation Committee appointed by the Council is a rough draft of a scheme which, coming from anyone but business men, would be dismissed as Utopian, but which, nevertheless, may prove workable.

The Committee propose that a permanent Committee representative of both capital and labour should be appointed to deal with questions arising out of labour disputes within the Metropolis. Whenever opportunity offers the Committee would in the first instance place the rooms of the Chamber of Commerce at the disposal of the disputants for the purpose of a friendly conference, and in the event of the failure to arrive at an amicable settlement the Committee would then offer to mediate or to select arbitrators. The Committee would further endeavour to promote the formation of Councils of Conciliation amongst the various trades of London, to be composed of employers and workmen, and it is suggested that such Councils might be affiliated to the London Chamber of Commerce.

A scheme of this nature will not fail to commend itself to employers. But it takes two to effect a conciliation as well as two to make a quarrel, and workmen have hitherto been inclined to view all such suggestions as the above with considerable suspicion, and before Mr. S. B. Boulton's proposals can become accomplished facts it will be necessary to disarm this suspicion by making the Committee thoroughly representative of the working classes—and such, indeed, we understand, is the firm intention of the Council. *Employés* will also have to be educated to the notion of reciprocity and compromise. At present their attitude is somewhat of the all-take-and-no-give character, and although perfectly ready to share the increased profits, they have up to the present generally claimed to be exempt from the reverse process.

"The Junior Engineering Society" visited the Victoria Works of the Brush Electrical Engineering Company on Wednesday, the 19th inst., and were shown over the whole of the departments. They were shown the manufacturing operations connected with the construction and trial of Brush dynamos, arc lamps, Victoria dynamos, the Brush Company's engines, a large number of which were being fitted with Victoria dynamos, principally for ship-lighting, Mordey-Victoria alternators and transformers of several sizes, Victoria motors for tramway and other work, and, in short, the manufacture of all kinds of electrical and engineering apparatus manufactured by this Company. In the testing department, which is provided with two 70 horse-power engines, machines of several kinds were being run, and the visitors were particularly interested in an alternator running on transformers, some of which were supplying incandescent lamps, while others were working on the Brush alternate-current arc lamps. The party evidently found their visit very interesting, and no doubt were impressed with the important position now being taken by electrical engineering.

The *soirée* given last week by the City and Guilds Old Students' Association, at the rooms of the Institute of Medical Electricity, although characterised by a somewhat strange combination of scientific and terpsichorean amusements, was a decided success. In one room of the Institute there was a formidable display of electro-medical apparatus, and in another the phonograph, which, like the poor, is ever with us, performed to its

Digitized by Google

own and everyone else's complete satisfaction. Mr. NEWMAN LAWRENCE lectured as pleasantly as the subject permitted on "Some New Forms of Electric Treatment," and an excellent concert restored the spirits of those who did not take kindly to the very light dose of medical electricity which was administered between the hours of nine and ten. Over a hundred persons were present, and dancing was energetically kept up until the necessity of catching last trains brought the evening's entertainment to a close. Since the Institution of Electrical Engineers inaugurated public dinners we have been inclined to believe in the reality of the present revival of electrical activity, and now that the Old Students have taken to dancing our last doubts are dissipated.

THE appeal of Mr. JOSEPH FREDERICK LEESON against the decision of Mr. Justice NORTH, which we recorded in our issue of December 20th, came on for hearing on Saturday last before Lords Justices COTTON, BOWEN, and FRY, who were unanimously of opinion that the General Medical Council acted within its rights in erasing Mr. LEESON'S name from the register of general practitioners. Lord Justice FRY, however, differed from the other members of the Court upon the question of the competency of the Council, holding that the fact that two of the judges were members of the Medical Defence Union was sufficient to invalidate the proceedings of the Council.

WE have received from Mr. HAROLD P. BROWN a circular letter containing a copy of the report and recommendations of the Health Department of New York, upon what they term dangerous systems of electric lighting. It was at one time thought that this crusade of Mr. BROWN'S was undertaken in the spirit of purest patriotism. How erroneous this impresson was cannot, we think, be better shown than by quoting the concluding sentence of the present letter:—"I therefore feel that this controversy has demonstrated my ability and energy, and respectfully ask to serve you if you are contemplating an investment in electric light or power systems: if you need expert examinations or advice concerning apparatus; if you wish lights tested and compared with contract requirements; if you wish dangerous features pointed out and corrected, or need expert assistance in patent or civil cases."

WE are glad to be able to contradict, on the authority of Signor ENRICO BIGNAMI, the editor of our esteemed Milan contemporary, *l'Elettricità*, the announcement which recently appeared in a contemporary of the death of Prof. PACINOTTI, of Pisa. The mistake, no doubt, arose from the fact that the great electrician's father died a few weeks ago.

Florence.—Particulars with regard to a proposed concession for the electric lighting of Florence will be found in our Trade Notes column.

L'Electricien.—Our esteemed contemporary *l'Electricien* announces that it intends to celebrate the tenth year of its existence by doubling its size.

Leeds.—The Highways Committee of the Corporation of Leeds have decided to invite general competition for the working of the entire tramway system of the borough.

The Electric Welding of Iron Pipes.—The McKeesport National Tube Works are introducing electric welding both for large and small iron pipes, for uniting the edges of the bent metal.

The Protection of Rubber Trees.—It is reported from Guatemala that a stringent law has been enacted there for the protection of rubber trees from careless bleeding, and that this law being strictly enforced.

Central Telegraph Staff.—On Tuesday the staff of the Central Telegraph Office held a meeting at the Foresters' Hall, under the presidency of Sir J. H. Puleston, M.P., for the promotion of civil service interests.

Warsaw.—Consular reports say that electric light installations are becoming very numerous in Warsaw, but they are generally contracted for by foreigners. Austria and Germany are being most concerned in the business.

The Society of Arts.—Sir Douglas Galton, K.C.B., F.R.S., will shortly read a Paper before this Society upon "The Sliding Railway," and Prof. S. P. Thompson upon "The Organisation of Secondary and Technical Education in London."

The Board of Trade.—The Railway and Electric Lighting Departments of the Board of Trade have become so large that it has been found necessary to provide other buildings for the office. The department will shortly remove to 8, Richmond-terrace.

The Sprague Motor Patents.—The Allgemeine-Elektricitäts-Gesellschaft, of Berlin, have secured the Sprague motor patents for Germany, Russia, Austria, and some other countries. The short line between Florence and Fiesole is being built by this Company.

Automatic Electric Lamps.—The latest company to adopt the "nickel in-the-slot" system of railway carriage lighting is the District Railway Company, who are fitting their carriages with electric lamps giving half an hour's light for the sum of one penny.

The City and Southwark Subway.—The experimental train on the Southwark Subway electric railway has now been running for about a fortnight successfully over a portion of the route, and it is anticipated that the line will be opened to traffic about next March.

Calvert's Mechanics' Almanack.—The 1890 edition of this useful little book is, as usual, full of practical hints for mechanics and others. A brief reference to electric lighting and transmission of power and to electric welding would, we think, greatly add to the value of the almanack.

The "Gymnote."—The accounts given in several papers of some recent performances of the electric submarine boat "Gymnote," at Toulon, show that this boat, the design of which is due to Commander Krebs and M. Zédé, is realising some of the sanguine anticipations of its inventors.

Field-Telegraph Work.—The work of laying the field-telegraph lines for the Chin-Lushai Expedition, says *Indian Engineering*, is making satisfactory progress. Permanent offices will shortly be opened at Lungleh on the Chittagong side and at Gungaw on the border of the Southern Chin country.

Telegraphing to Moving Trains.—The system of telegraphing between moving trains and railway stations is rapidly becoming general in the United States. The Pennsylvania Railway Company now telegraphs Stock Exchange quotations to the express trains running between New York and Chicago.

Swansea.—At the last meeting of the Swansea Town Council, it was resolved to appoint a Sub-Committee to prepare specifications and receive tenders for the purpose of lighting by electricity the streets in Schedule A of the Swansea Lighting Order. The Committee was empowered to engage the services of an electrical engineer.

Marylebone Vestry and the Tramway Schemes.—At a meeting of this Vestry last week, it was decided, on the recommendation of the Parliamentary Committee, to oppose the London Central (Subway) Central Railway Bill and the Central London Railway Bill, the inhabitants of Oxford-street agreeing to contribute a moiety of the expenses.

The Railway Diary and Officials' Directory.—We have received from Messrs. M'Corquodale the "Railway Diary and

Digitized by Google

Officials' Directory," and the "Railway Almanack." The Diary and Directory contains a quantity of useful information, particularly for those wishing to communicate with the *personnel* of the great railway systems throughout the kingdom.

Alzano.—An electric lighting company which was recently formed at Alzano, near Bergamo (Italy), has given a contract to the Italian Edison Company for the erection of the entire plant, consisting of two 50-kilowatt 2,000-volt Zipernowsky alternators. The station is situated one and a-quarter miles from the town, and the necessary motive power is supplied by a waterfall.

Appointment Vacant.—The Governors of the Heriot-Watt College, Edinburgh, are about to appoint a Professor of Physics and Electrical Engineering. Applications for the post must be sent to the Treasurer of George Heriot's Trust, 20, York-place, Edinburgh, on or before January 20, 1890. The salary will be £400 per annum. Further particulars are given in our advertisement pages.

The Column Printing Telegraph Patents.—The Comptroller of Patents last week gave his decision in the case of the opposition of the Exchange Telegraph Company to the grant of letters patent for a column printing telegraph instrument, owned by the Column Printing Telegraph Syndicate (Limited), in favour of the latter. The patent for the column printing machine will accordingly be issued.

Lectures on "Electricity."—On Friday evening last between 600 or 700 persons assembled in the New Baths, Battersea, to hear Mr. W. Lant Carpenter deliver the third of a series of lectures on "Electricity," which are being given in connection with the Battersea Polytechnic. In consequence of the success of this series of lectures, the Polytechnic Committee have decided to arrange for ten additional scientific lectures on kindred subjects being given.

Fire in the City.—An alarming fire broke out on Christmas morning in Charterhouse-square, London, E.C., in which is situated the building occupied Mr. S. Z. de Ferranti. From accounts received, we are pleased to say that nothing has happened which is likely to seriously interfere with the regular course of business, although the fire was one of the most extensive that has happened in the City of London for some years. The fire did not originate in the premises occupied by Mr. Ferranti, but at those of an adjoining printers.

A New Insulating Material.—According to the *Chronique Industrielle*, another new insulating material has just been produced. It consists of one part of Greek pitch and two parts of burnt plaster, by weight, the latter being pure gypsum raised to a high temperature and plunged in water. The mixture, when hot, is a paste, and can be applied by a brush, or cast in moulds. It is amber-coloured, and can be turned and polished. Its advantage is said to be its endurance of great heat and moisture without injuring its insulating properties.

National Telephone Electrical Society.—At the meeting of this Society on Friday evening last, Mr. Loghes, the construction inspector of the Midland District of the National Telephone Company, read a Paper on "The Construction and Maintenance of Telephone Lines." The lecturer dealt with the erection, arming, and earthing of poles, standards, and other fixtures; the regulation of dip, or "sag," and the "twist" method of running metallic circuits. A neat model of a complete route on the "twist" method assisted the lecturer in his explanations.

Presentation to Mr. T. Parker, of Wolverhampton.—Mr. T. Parker, of the well-known Elwell-Parker Works, was presented on Saturday last, at the Drill Hall, Wolverhampton, with a silver tea service and a framed illuminated address. The presentation was made as a mark of the esteem in which Mr. Parker is held by the *employés* of the Electric Construction Corporation, many of whom were in the employ of the firm of Elwell-Parker (Limited) before the transfer to the Construction Corporation. The Mayor of Wolverhampton presided, and the proceedings throughout were of the most cordial character.

Technical Education in New South Wales.—The Government of New South Wales has adopted an entirely new scheme of technical education. The present Board of Technical Education is to be abolished, and technical schools will be placed under the direct control of the Education Department. A sum of £50,000 is to be expended in the erection and equipment of a new Technical College and Museum in Sydney, while branch technical schools will be established throughout the country districts. It is estimated that £50,000 will be required annually to carry out the new arrangements.

The Electric Lighting of the Russian Imperial Train.—The Russian Imperial Train has recently been fitted with the electric light. The train comprises some 12 or 13 carriages, one of which contains a "Nobel" boiler, a Brotherhood engine, a 12-unit dynamo, a petroleum reservoir, and a water-supply tank. The electric installation, which has been carried out by the Jablochkoff Company, of St. Petersburg, comprises 253 30-volt 30-watt incandescent lamps, run direct off accumulators distributed in three of the carriages. The light is moderated by interposing a frosted or tinted glass shade. The accumulators ensure light for 20 hours, but they can, if necessary, be charged during the journey.

Proposed International Memorial to James Watt.—A proposal has been set on foot in Greenock to erect there an international memorial to James Watt. The local Philosophical Society has taken the matter in hand, and has appointed an influential committee, to co-operate with a large committee under the auspices of the Town Council, to approach scientific and engineering societies in London, Glasgow, Edinburgh, and other large centres, with the object of securing their sympathy and practical co-operation. Various suggestions as to the form the memorial should assume have been under consideration, and one of the proposals mentioned is that a thoroughly-equipped technical school should be erected in Greenock.

The Dangers of Electricity.—In view of the present outcry about the dangers of the electric light, and the many absurd restrictions which are being proposed, it is interesting to recall the protest drawn up by the Royal College of Bavarian Doctors in the early days of railways. They stated that travel in carriages drawn by a locomotive ought to be forbidden in the interest of public health. The rapid movement would produce among the passengers the mental affection known as *delirium furiosum*. Even if travellers were willing to incur this risk, the Government should protect the public. A single glance at a locomotive passing rapidly was sufficient to cause the same cerebral derangement. Consequently it was absolutely necessary to build a fence 10ft. high on each side of the railway.

The "Faraday" Electric Works.—The second annual gathering of the *employés* and friends of the "Faraday" Electric Works took place in the Masonic Hall, Burndyke, on Friday last, Mr. Wm. M'Whirter, M.I.E.E., presided. The Chairman, in the course of his remarks, said he was glad to be able to say that their progress last year had been considerable. Looking over the list of orders executed and those on hand, he found that their output would be something like treble what it had been in any previous year. A year ago they were seriously considering what was to be the future form of the dynamo. If the results of further experiments were the same as those of the first experiment, their dynamo of the future would be a dynamo where wrought iron would be abandoned in favour of cast iron.

The Jamaica Exhibition of 1891.—It is proposed to hold in Kingston, Jamaica, in the year 1891, an exhibition of the products, manufactures, and works of art from the island itself, and works of art, machinery, and industrial and agricultural products from the United Kingdom, and other countries and colonies. The exhibition, which will be opened on January 27, 1891, will remain open for not less than three months, and will be under the management and conduct of the Commissioners, at the head of whom is the Governor. The regulations for exhibitors are now published, and from these it appears that applications for space must be in the hands of the secretary by May 1, 1890. Communications and applications for forms and regulations must be addressed to Mr. C. Washington Eves, 1, Fen-court, E.C.

The Violle Light Standard.—A new pattern of the Violle Light standard has recently been devised by M. Carpentier. In the new arrangement, the fusion of the platinum is effected by a jet of mixed illuminating gas and oxygen, which plays

Digitized by Google

upon the platinum ingot placed in a hollow in a block of lime. This block is in two parts, the upper part (through which the gas jet passes) being movable by means of a handle. The lower part of the block is arranged so that it can be slid from under the upper block to a position beneath a shield with a hole in the centre, whose area is 1 square centimetre. An inclined mirror above this shield enables the surface of the glowing platinum to be seen at right angles to the same. The handle enables the upper half of the block to be moved aside, so that it can be seen if the platinum is melted.

The Post Office and the Use of the Telephone.—The Leicester Town Council, the Chamber of Commerce, and the Trade Protection Society recently appealed to the Postmaster-General on a very important point connected with the use of the telephone in cases of fire or riot. The question arose in consequence of a delay in the transmission of an alarm of fire. The local post office officials decided that as the fire did not originate on the premises of the renter of the telephone he was not entitled to use the telephone for the purpose of informing the fire brigade, the telephone communication being restricted "to his own business and private affairs." The Postmaster-General has now written to say that, while the use of the telephone is restricted to the renter's own private and business affairs, the department will be only too glad to allow its use to convey information concerning the outbreak of fires or of rioting.

Courses of Lectures.—Our readers will be pleased to learn that Prof. Perry's special course of 13 lectures on the "Differential and Integral Calculus and its Applications in Mechanical and Electrical Engineering," which proved so successful last year, will be repeated at the Finsbury Technical College, Leonard-street, E.C., the date of the first lecture being January 7th. Students are expected to know elementary algebra and trigonometry. It is well known to be Prof. Perry's view that all practical engineers use the notions and methods of the calculus in their daily work: those of them who think themselves ignorant of the calculus are merely afraid of the symbols $\frac{dy}{dx}$ and $\int y \, . \, dx$——A course of lectures will also be given, at the Central Institution, Exhibition-road, S.W., by Prof. W. E. Ayrton, on "Electrical Technology." The lectures will be given on Mondays and Wednesdays, commencing on January 15th next.

Incandescent Lamps on Buoys.—A recent report, made by Captain Millis, of the United States Lighthouse Board, in relation to the electric lighted buoys at the Gedney's Channel entrance to New York Harbour, states that a year's service shows that the system is a practical success. The buoys withstood heavy storms without drifting from their positions, and not more than two lamps out of six were extinguished at any one time. On one occasion a buoy was run down by a vessel and entirely submerged without injury. Some trouble has been experienced from moisture getting through the lamp sockets and destroying the connections, but a new form of lamp has been devised which promises to be free from this objection. It has been found that the life of lamps made with red glass globes was much shorter than that of the uncoloured ones, an effect which was attributed to the interception of a greater portion of the heat radiated from the carbon filament, and lamps with bulbs of clear glass are now used on all the buoys, lanterns lined with red glass being used to produce the red lights. Captain Millis notes the fact that a building on shore very near the buoys was twice struck by lightning while the buoys and their connecting cables were uninjured.

The Administration of Drugs by Electricity.—At a recent meeting of the Harveian Society, Dr. Cagney said that experiments by Eulenburg, von Bruns, and Hermann Munk had shown that certain drugs could be made to pass through animal tissues between the poles of a galvanic current, and he himself had used iodide of potassium in this way for the cure of lead palsy. Only very small doses, however, could be administered through the skin. The method was best adapted for the treatment of diseases of the skin and mucous membranes, or of small tumours immediately beneath them. In the application of the method a very strong current was not needed, but a sufficient current density was required, and the tissues under treatment must be brought directly in the path of the current. The electrodes might be either sponges holding solution of iodide of potassium or a modification of Dubois's conducting tubes filled with the fluid. The electrodes should be of large surface area. The fluid should be a saturated solution of iodide of potassium, and it ought to be supplied, where possible, at both poles. Where this was not possible the solution should be at the negative pole. The current should be passed for 10 to 15 minutes, and its strength would be determined by circumstances. Its direction should be reversed every minute. Mr. Juler remarked that the method had given excellent results.

Smith's Method of Making Amalgamated Storage Battery Plates.—One of the methods which has been largely employed in the past in order to prevent the oxidation of the supporting plates in a storage battery has been the amalgamation of the plate. This has generally been effected by adding to the molten lead a certain quantity of mercury. This process, however, does not always give uniform results, on account of the volatilisation of the mercury, so that the exact quantity combining with the lead is uncertain. To avoid this, Mr. Walter F. Smith, of Philadelphia, has devised a method by which an amalgam previously prepared is added to the molten lead in definite quantity. The manner in which the amalgam is prepared involves an electrolytic process, and is accomplished as follows: A quantity of mercury is made the cathode of a cell and metallic lead the anode, a dilute solution of nitrate of lead constituting the electrolyte. A current of electricity is then passed through the electrolytic cell and the ensuing electrolysis allowed to continue until the mercury has permeated a large proportion of the lead. The amalgam thus formed is then placed in a straining appliance, and the nitrate of lead removed by washing and the excess of mercury strained off, leaving the mass in a plastic condition suitable for combining with molten lead. In practice it has been found that about four per cent. of the amalgam introduced into the lead before casting the compound into supports gives excellent results and prevents oxidation.

Dry Batteries.—The earliest *dry pile* was devised by De Luc. De Luc's idea was very much improved by the Abbé Zamboni, who thought he had given to the world at last the perpetual motion. Zamboni's pile, as is generally known, consisted of sheets of paper covered with thin laminæ of tin or zinc on one side, and well rubbed with the dioxide of manganese on the other. Later, the discs were formed of "gold" and "silver" paper pasted back to back. The development of the dry battery has made considerable progress during the last few years, attention having been given on the Continent to the subject by Guérin, Edelmann, Pollak, Wagner, and Gassner. The Gassner battery is simply a cylinder of zinc, open at the top, and closed at the base with a non-conducting material; the zinc forms the negative pole. The positive pole consists of a piece of carbon placed within the cylinder. The space between the carbon and the zinc is filled up with a mixture of gypsum and oxide of and the cell is then sealed down with cement. In the Trouvé zinc, pile, soft, bibulous paper is used in discs, thoroughly soaked with solutions of sulphate of copper and sulphate of zinc. Bagration employed earth saturated with sal-ammoniac: Minotto, sand and sulphate of copper; Wolf, Keiser, and Schmidt, sawdust or cellulose. Desruelles, taking the Leclanché cell, endeavoured to make it portable by filling up the space reserved for the sal ammoniac solution with asbestos fibres or spun glass, which soaked up the liquid, Germain used cocoa-nut fibre for the same purpose, D'Arsonval employed animal charcoal. Beetz and Schuler employ sulphate of copper and sulphate of zinc mixed with sulphate of lime or gypsum. Burstyn uses gypsum and chloride of copper mixed with chopped cotton wool. The essential feature of Pollak's dry pile consists in the use of "gelatine-glycerine," mixed with the exciting salts. This substance is admirably hygroscopic; it has been employed by Edelmann in the construction of his pocket battery. Lastly, Raoul Guérin, of Paris, has laid under contribution a new hygroscopic material, for use in dry piles, analogous to gelatine: it is called "la gelosine de Raoul Guérin," and contains a large quantity of the exciting salts.

Digitized by Google

THE UNDERGROUND MAINS OF THE HASTINGS ELECTRIC LIGHT COMPANY.

BY W. B. SAYERS.

At a time like the present, when many electrical engineers have the difficult task before them of deciding upon a method of laying underground mains, and when not a few new schemes are on the point of being tried, it may be helpful to those whose object is to secure success at any reasonable cost, as distingushed from those who are content to risk present failure in the hope of ultimately attaining a more striking success with a novel system, to consider the conditions under which underground mains have been employed by the Hastings and the Eastbourne Electric Light Companies during the last six years, and the result of the experience of these two companies.

By the courtesy of the secretary, Mr. Ed. W. J. Hennah, and the engineer, Mr. Mercer, of the Hastings Company, the writer has had an opportunity of examining the test books, which contain records of the daily insulation tests back to 1885; and he is thus in a position to give the averages of these tests for the months of June and November up to the present year, and also a general description of the Company's experience as regards underground mains. The Company at present employs the old type Brush dynamos, with cast-iron armature rings. The normal capacity of each machine is 40 arcs of 10 amperes current. By far the greater part of the lighting is by incandescent lamps, which are arranged on the well-known system of groups in series. The mains consist unformly of seven 16 B.W.G. strand cables, insulated either with gutta-percha or indiarubber, and drawn into cast-iron pipes 4in. in diameter, service wires being taken off in 1½in. pipes. There are four independent circuits in all, each worked by a separate dynamo, while one spare dynamo is kept running in case of necessity. The dynamos are mounted on a well-insulated platform, which arrangement relieves the cables of unnecessary strain, especially if the dynamo insulation is not very high. Returning to the mains, No. 1 circuit has a total length of 6½ miles, and operates 30 Brush arc lamps situated along the Marine Parade, outside shops, and in other exposed positions; No. 2 circuit is 3½ miles long, and supplies 300 16 candle-power incandescent and one arc lamps; No. 3 circuit is 3½ miles long, supplies 300 16 candle-power incandescent and one arc lamps; and No. 4 is 6½ miles long, and supplies 400 incandescent lamps, making a total of about 20 miles of cable.

The Company started work in November, 1883, when the mains consisted entirely of cables with thin (less than $\frac{1}{16}$in. gutta-percha insulation with an outside braiding. These cables began to give trouble from the very first, and complete breakdowns of the lighting were constantly recurring. Early in 1884, Mr. Mercer, the Company's engineer, commenced replacing the thin gutta-percha insulated cables with much more heavily-insulated indiarubber covered cables of a type first made specially for Mr. H. M. Sayers, then engineer to the Eastbourne Company. This cable has proved itself equal to the strain of 1,500 to 1,600 volts continuous E.M.F., which it has had to withstand at Hastings. As indicated above, the first length of it was drawn in in 1884, and from that date whenever a fault has occurred in the original gutta-percha cables the faulty length has almost invariably been replaced by the heavily-insulated rubber cable, with the result that at the present time over 10 miles out of the total 20 miles are of this cable. The remaining 10 miles consists of 1½ miles of a thicker gutta-percha cable, which has also proved successful, about six or seven miles of the original thin gutta-percha cable, and between one and two miles of other types. The three principal types of cables in use are as follows: No. 1 is insulated with two coats of gutta-percha, the total thickness of the two coats being slightly less than $\frac{1}{16}$in., then braided. No. 2 is also insulated with two coats gutta-percha, about twice the thickness of No. 1, then braiding of a substantial character. The 1½ miles of this cable has stood well, especially on the pier, where it was put in in 1884, and has never shown a leak or required touching, though in some places the braiding has rotted off completely. No. 3 is by far the most expensive cable, costing about £120 per mile: the sample examined had first a coating of very thin pure rubber wound on spirally to protect the copper from the action of the sulphur in the other coats, then a layer of white vulcanised rubber, and then a layer of equal thickness of grey rubber—the total diameter over the rubber coverings being 0·425in.; next came a serving of prepared tape, and over all three servings of tarred canvas laid on in reverse directions. The outside diameter of the cable is 0·75in. Mr. Mercer says he has never had to replace a single length of this cable, and he consequently uses it with the utmost confidence.

A daily record of the insulation tests has been kept since 1885, and below will be found the average values of the insulation resistances for the four circuits during the months of June and November for each year up to the present, 1889:—

——	No. 1 Circuit.	No. 2 Circuit.	No. 3 Circuit.	No. 4 Circuit.
	Ohms.	Ohms.	Ohms.	Ohms.
June, 1885	105,967	195,322	...	...
Nov., ,, ...	207,533	118,533	...	...
June, 1886	192,800	107,500	...	...
Nov., ,, ...	120,133	253,800	189,666	...
June, 1887	575,333	283,600	231,633	...
Nov., ,.	74,366	299,833	181,700	...
June, 1888	258,100	141,900	115,800	...
Nov., ...	91,633	122,566	88,933	...
June, 1889	242,266	154,333	103,133	92,166
Nov., ,, ...	147,700	223,500	260,000	193,000

The figures represent the insulation of switches, fuses, lamps, &c., and if all these were disconnected, and the cables joined up, obviously a much higher result would be obtained. An examination of the test-record shows that 12,000 ohms is the lowest insulation resistance which any circuit has shown without a fault having been the cause; while in August, 1888, a resistance of only 7,000 ohms was given by circuit No. 3, when a fault was localised and removed. At the same time cable faults of as high a resistance as 100,000 ohms have been localised and removed. Nothing but practice and experience in the observance of the behaviour of machines and lamps, as well as the behaviour of the instruments when the test is being taken, and the state of the weather can enable any one to judge with accuracy whether a fault exists in the circuit, or whether a low reading, or succession of low readings, is caused by surface leakage at switches, fuses, or lamps, or in the case of arc lamps, even over the surface of damp globes. Given the required experience and observance on the part of the engineer in charge, and a cable fault of 100,000 ohms resistance and upwards gives sufficient evidence of its existence to enable it to be traced and removed. At Hastings faults are now of very rare occurrence. The last one which caused a stoppage of lights was in December, 1887, when a short-circuit occurred in No. 2 circuit close to the station. The most recent leaks which have been remedied occurred in August, 1888, on No. 3 circuit, and in October, 1888, on No. 1 circuit. These were both traced to the No. 1 quality cable—that is, the first put in. An examination of the actual "faults" removed shows them to be due invariably to one of two causes, viz., defects in manufacture, which have gradually developed "pinholes" under the action of the leakage current—infinitesimal at first, but none the less surely operative; and mechanical injuries, received either in transit, whilst being drawn in, by being sawn into by other cables drawn into the same pipes, or by too sharp bends over corners of projections, or from kinks.

Mr. Wilkinson, of the Eastbourne Company, states that the underground mains employed by that Company, which consist of similar indiarubber cables drawn into iron pipes in a similar manner, have given no trouble with the 2,000 volts alternating E.M.F. to which they are subjected.

The experience of these two Companies points to but one conclusion, which is, that even a thin coating of either rubber or gutta-percha, if the coating is only perfect from end to end, is sufficient to withstand 1,600 to 2,000 volts, either direct or alternate. The process which has been going on at Hastings has simply been the weeding out of the lengths of cable which contained either mechanical injuries or defects which occurred

Digitized by Google

during manufacture, and this process has now been carried on to such an extent that even the 6½ miles of the original thin gutta-percha covered cable which remains in use seems capable of standing the work indefinitely. The advisability of subjecting all cables to a severe and prolonged test under a high potential has often been urged, and in the light of the results of experience at Hastings and Eastbourne, certainly no pressure of circumstances should ever be allowed to interfere with the thorough testing and proving by means of a high E.M.F. applied for several days at least to every length, and the rejection of every unsatisfactory length unless the weak point can be localised and cut out. But there is another point of no less importance, and that is the handling of the cable when it has withstood the test. Too much care and thought cannot be exercised when making the arrangements for drawing into the pipes or conduits. In the summer of 1883 the writer was engaged in connection with the lighting of the Birmingham Town Hall for the occasion of the Musical Festival of that year. The dynamos were driven by the mill engine in a well-known sheet metal and tube works in Cambridge-street, a distance of about 500 yards from the Town Hall. Underground mains were decided upon, and a double set of eleven 7-16 B.W.G. strand cables were employed: twenty-two cables in all. Four-inch pipes were procured from the water company and the more prominent projections on the inside of the pipes removed or rounded off by dragging several lengths of a heavy chain backwards and forwards through each pipe for about 15 minutes. The testing, drawing in, and jointing of the cables were arranged and supervised by Mr. Fleetwood, of the Post Office, who took the greatest precautions against mechanical damage. Each eleven 110 yard lengths of cable were laid together and wound from end to end with canvas strip, a brass trumpet-mouth funnel was put into the end of the pipe at which the bunch of cables entered, and two or three pounds of soft soap put into the mouth of pipe and over the ends of the cable to lubricate the surface and make all go smoothly. For several years no faults whatever occurred in these cables, and they are still in satisfactory order, lighting the Town Hall, the Birmingham and Midland Institute, and one or two other adjacent buildings. The E.M.F. employed is 240 volts, and the cables are insulated with gutta-percha about 0·075in. thick, braided over all. What can be more manifestly absurd than to pay a high price for a cable and to exact guarantees from the maker that the insulation resistance is so many megohms per mile, to spend a great deal of time and trouble in testing and proving the manufacturer's work, and then to hand it over to unskilled labourers and inexperienced pupils to uncoil it and entangle and kink it, to re-coil it and uncoil it again, and finally to drag it by main force into the pipes, without any efficient precautions against abrasion or damage from overstraining, should any hitch or kink occur at the ingoing end? Yet this is the kind of treatment to which underground electric light cables have been, and doubtless are being, subjected in many instances. No surprise need be felt if the insulation of such cables failed to stand the test of regular work.

SIR WILLIAM THOMSON'S NEW INSPECTIONAL ELECTRIC INSTRUMENTS.

The following instruments of Sir William Thomson have not, we think, been hitherto fully described:—

The Magneto-static Current Meter.

The Magneto-static Current Meter consists essentially of a small steel magnet or system of magnets suspended in the centre of a uniform field of force due to two coils, each having one or more turns of copper ribbon or wire, and also under the directive influence of two systems of powerful steel magnets. The suspended system of magnets is attached to one end of a vertical shaft passing down centrally through an opening in the sole-plate of the instrument from an indicating needle. The two systems of directive magnets are circular in form, and each ring is composed of two semi-circular magnets placed in a brass cylindrical frame with their similar poles together. Each system is securely fixed to a circular brass frame, which fits on to the cylindrical case of the instrument in such a manner that the systems are capable of being turned round, together or separately. The instrument has a "tangent scale," consisting of a hundred divisions, which is adjusted in its position before the instrument is sent out, so that the needle indicates equal differences of readings for equal differences of current.

The instrument has an advantage, important for some practical purposes, of being available as an accurate direct-reading current meter, through a continuous range of from 1 to 100 times its smallest current, which may be anything from half a milliampere to four amperes, according to the number of turns in the coils supplied with the instrument. It is not, however, available as an alternate-current instrument, and it must be remembered that the magnetism of the steel directing-magnet does not remain *absolutely* constant. With good quality of steel, a proper preliminary *ageing* of the magnet (by heating it several times in boiling water and cooling it again, and subjecting it to somewhat varied rough usage) brings it to a condition in which its magnetism is found to remain exceedingly nearly constant month after month and year after year. Still it should never be relied upon as *absolutely* constant, and for accurate laboratory work it is therefore necessary to have some means of re-testing the instrument at any time. Another advantage which the instrument has is that, when a standard instrument is available, its constant is capable of being varied to any desired value down to one-tenth of that which it has with its directive magnets in their strongest position. Thus if the constant should be three amperes per division of the scale, with the similar poles of the magnets coinciding, it may be adjusted to any value down to 0·3 ampere per division.

The two grades of this instrument which are found most convenient are:—The Milliamperemeter, which has an effective range of from ·3 to 300 milliamperes, and is usually adjusted to read two milliamperes per division, and the Amperemeter, which has an effective range of from ·3 to 300 amperes, and is usually adjusted to read one ampere per division.

One very convenient use of the latter instrument is to act as a lamp-counter for indicating the number of incandescent lamps in use in an installation. For this purpose it is best to standardise it by putting on a known number of lamps and adjusting by the magnets until the desired reading is obtained on the scale. Of course this numbering of lamps is not possible to any great accuracy, because the lamps themselves are not all rigorously equal in the amount of current which each takes, but the lamp-counter serves the important practical purpose of showing at any time the number of lamps in use nearly enough for practical purposes. The Milliamperemeter, on account of the low resistance of its copper coil—about 40 ohms—may conveniently be used as a voltmeter. To adapt it for this purpose a copper cylinder, wound anti-inductively with two platinoid resistances, is supplied. The first of these, together with the resistance of the instrument, makes up 100 ohms, and the second alone is 900 ohms. Thus, taking the constant of the instrument at 2 milliamperes per division, by joining the smaller in series with the instrument, the reading on the scale will be 1/5 of a volt per division; with both resistances in series with the instrument the reading will be 2 volts per division.

The Ampere Gauge.

The Ampere Gauge (see Figure) is of simple construction, having a vertical base-plate of paraffined marble, to which are attached:—(*a*) A solenoid of special form; (*b*) Brass bearing plates supporting a balance which carries a soft iron plunger on its one arm and a brass counterpoise weight on the other; (*c*) A brass arc having a scale graduated to give direct readings in amperes; (*d*) A hinged arm which bears a light checker. The solenoid is built up of copper plates with mica insulation between them, and is fixed to the base-plate so that its core is vertical. The balance is supported on knife edges at such a distance below the solenoid that the top end of the plunger is slightly entered into the core. The plunger is made from a thin soft iron wire about 20 centimetres long, and is supported by a cross-bar with two hooks on it which pass over two knife-edge stirrups on the arm of the balance. It has a brass weight hung on its lower end in order

Digitized by Google

to keep it in a vertical position and prevent its being attracted against the side of the solenoid. An indicating needle, or pointer, formed from a strip of platinoid, passes down from the trunnion of the balance to the brass arc bearing the graduated scale. As the plunger is attracted upwards this pointer passes round the scale and indicates the strength of current passing through the solenoid.

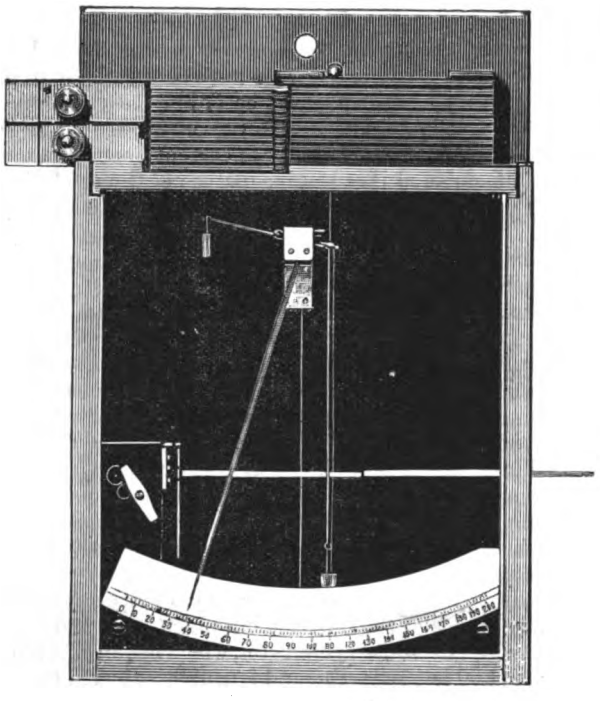
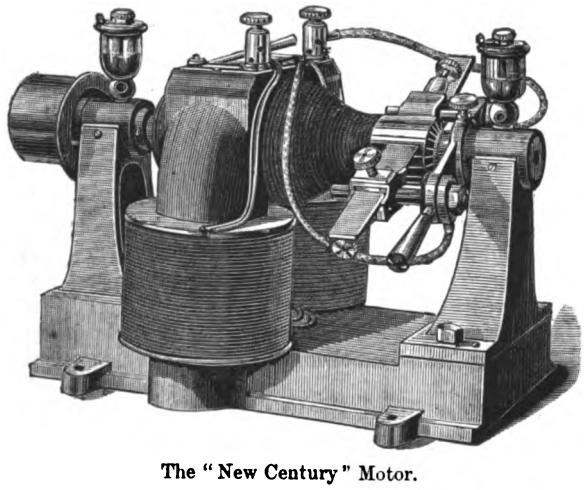


Fig. 1.—The Ampere Gauge.

Several types of the Ampere Gauge are made, covering a range from 0·5 to 500 amperes, and are available as measurers of electric current on either direct or alternating circuits. They are standardised by direct comparison with Sir William Thomson's Standard Electric Balances, and, when the instrument is intended for alternating currents, the graduation is made to suit the period of alternation in use on the circuit for which it is desired.

THE "NEW CENTURY" ELECTRIC MOTOR.

Among the numerous American Companies who propose to "open up" business in England is the New Century Dynamo



The "New Century" Motor.

Company. This Company makes a special feature of its motors, one of which is illustrated in the accompanying engraving. It is of the inverted horse-shoe type. The distinguishing feature of the machine is the construction of the magnetic circuit, the magnetic cores, pole-pieces, the yoke and base, together with one of the bearings, being all cast in one piece; the absence of joints considerably reducing the resistance of the magnetic circuit. The armature is of the Siemens-drum type. The field-magnet coils are separately-wound on pasteboard tubes with fibre flanges, the whole being then slipped over the magnet cores. The shaft which carries the armature is made of high-grade steel turned exactly to gauge, and all other parts are made interchangeable. The commutator is made of Tobin bronze, an excellent wearing metal, and is insulated with mica and carefully backed. The motors are shunt-wound and have a three-point starting switch on top of the machine, which obviates the use of a separate resistance box. The first contact on this switch throws the field in circuit, thus magnetising the cores and permitting the motor to start itself. The second contact puts in the armature and also a resistance in series with it to prevent the armature from burning out when starting. The last contact short-circuits this resistance after the motor has obtained its proper speed, and it then acts as a simple shunt-wound motor, keeping its speed practically constant, there being but a slight variation between full load and no load.

The New Century Company also manufactures a large number of electro-plating machines.

THE ACTINO-ELECTRIC RESEARCHES OF M. STOLETOW.*

The phenomenon studied by Stoletow and discovered by Hertz, namely, the discharge of electricity by light, has been the object of numerous works by Wiedemann, Hébert, Righi, and others. Stoletow has, however, devised a particular method which gives his investigations an entirely original character, and which has given rise to some interesting results.

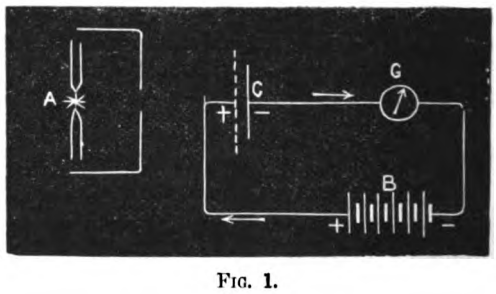


Fig. 1.

In Fig. 1 we have a diagrammatical representation of his method. A is a Dubosq arc lamp with the lenses taken away, run off a dynamo giving 70 volts and 12 amperes. A condenser consisting of two metallic discs, ·22mm. in diameter, is arranged in front of the opening of the lamp. These discs are not similar, the one nearest the lamp consisting of iron or brass network, the other is a plate of the ordinary description. These two discs are arranged in a vertical plane, are parallel, and the distance between them can be altered as desired. The light passing through the network strikes the near coating of the plate, which thus becomes the seat of actino-electric phenomena. The two coatings of the condenser C are connected by a metallic circuit containing a battery, B, a sensitive Thomson galvanometer, G, which deflects one division for every $2{\cdot}7 \times 10^{-11}$ amperes, or one division for $6{\cdot}7 \times 10^{-10}$ amperes when the controlling magnet is taken away.

With the apparatus so arranged M. Stoletow obtained the following results:—When the plate was connected to the negative pole and the network to the positive, there was a current in the condenser circuit each time that the light of the arc fell upon the negative plate. If the connections were reversed the actino-electric current was scarcely perceptible. If it were not completely stopped, it was because the negative pole (the network) was still lighted up by reflected light; but if the sensitiveness of the network were diminished (we shall see further on that to attain this result it was only necessary to slightly wet it) the current completely disappeared, so that Stoletow agrees with previous observers in asserting that the actino-electric current is unipolar. The voltaic arc was not the only cause of these phenomena: gas flames, magnesium light, induction sparks, gave rise to the same effects,

* From *La Lumière Electrique.*

Digitized by Google

though in a feeble manner. Sun rays seemed to have no action at all. M. Stoletow has exposed his condenser at right angles to the sun's rays, and although the plates of the condenser were only 1mm. apart and its potential was 212 volts, there was no current. Under the same conditions, when the condenser was exposed to the light of the voltaic arc, there was a current of $640 \times 6{\cdot}7 \times 10^{-10}$ amperes. The introductinion to the voltaic arc of metallic vapours, especially those of aluminium, considerably increased the actino-electric effects, and, generally speaking, all gases which increased the number of rays of great refrangibility in the arc also increased the actino-electric action. On the other hand, all substances, opaque or transparent, which absorbed these rays when interposed between the light and the condenser, immediately stopped the actino-electric current. Such was the effect of glass. Water, quartz, ice, are more or less transparent to the ultra-violet rays, and are consequently to a certain extent transparent with regard to actino-electric action. Amongst the gases air and hydrogen are transparent, but coal gas, ammonia, and the vapours of sulphate of carbon are nearly completely opaque. An interesting peculiarity ought perhaps to be mentioned here. If the surface of the negative plate which received the action of the light was covered with an extremely thin coating of some transparent material, the actino-electric action was rapidly reduced to nothing. Hence the actino-electric current instantly ceased if a little water was poured on the negative plate, or even if it was breathed upon. On the other hand, if the negative surface was covered with a material which absorbed the active rays, it became more sensitive ; hence colouring substances double and treble the actino-electric sensitiveness of the condenser. These effects indicate the part played by the violet rays in the production of the phenomenon, and show at the same time that the *surface* of the negative plate plays the most important part. The experiments of Lenard and Wolf on the pulverisation of the negative surface by light leave, moreover, no doubt on this point. The different metals have not any marked specific sensitivity, but the study of their surface may considerably alter the constant. Thus freshly-cleaned metals are the most sensitive, but they become quickly "fatigued," so that if constancy is required freshly-cleaned metals should *not* be employed. The temperature seemed to have but little effect, but, generally speaking, increase of temperature increased the sensitiveness of the apparatus. This variation in the sensitiveness of the metallic surface rendered accurate measurements very difficult ; but the arc, with its inevitable unsteadiness, was a still greater cause of inaccuracy. The best of arc lamps are not absolutely steady, and the fluctuations of the current due to the irregular action of the machine resulted in a very visible oscillation of the arc. For this reason, M. Stoletow devised a second condenser to neutralise the effect of these oscillations.

This second "controlling condenser" only differed from the first in the shape of its plates, which consisted of two parallel metallic crosses 22cm. long and 2cm. broad, placed 2mm. apart. This condenser was arranged parallel to the first and nearer the arc, so that the same light fell upon it. The controlling condenser was charged by 25 Clark cells, and its circuit contained a galvanometer, the needle of which oscillated isochronously with that of the main circuit galvanometer. The observations were taken simultaneously by two people. At the commencement of each series of experiments (which did not last long, since the two condensers became unequally fatigued), the coefficient of comparison between the indications of the galvanometers was established. The figures given by M. Stoletow show a pretty satisfactory agreement between observations and results calculated by means of the coefficient of comparison. The employment of a controlling condenser led M. Stoletow to study the influence of the intensity of light, of the surface of the electrode, and of time upon the strength of the electric current. By means of a cardboard disc cut into equal sectors, and revolving at a known speed, it was found that the intensity of the actino-electric current was proportional to the active rays (ultra-violet). If a certain portion of the negative disc was covered with transparent substances, which annulled the action of the light, it was found that the current was proportional to the surface. Finally, a commutator, fixed upon the axis of rotation of the cardboard disc, permitted one to introduce or take out from the circuit the actino-electric current for a certain portion of the angle of rotation—that is to say, during an extremely short time. By these means it was ascertained that the action of the light is practically instantaneous, the retardation being less than one-thousandth of a second. This conclusion is contrary to the view of M. Borgmann, another Russian scientist who has devoted himself to this question, and who employed a telephonic method ; but it seems that the experiments of M. Borgmann can be interpreted in another manner.

With his controlling condenser M. Stoletow carried out a series of measurements with a view of studying the actino-electric current as a function of the distance between the plates of the condenser, and of its potential. The plates of the condenser which was employed in these investigations were of silvered brass. The negative plate always occupied the same position, and the network alone was displaced. The distance between the plates in these experiments was varied from X+1 to X+95mm. (X=1·5mm.). The E.M.F. of the battery varied in one series of experiments from 1·4 volts to 140 volts ; in another series between 1 Daniell and ·05 Daniell. The results of these experiments are shown in Fig. 2. The greater the distance (δ) the further off from the point of origin is the bend of the curve. Comparing the curves, M. Stoletow first showed that C is a function of $\frac{E}{\delta}$, which he verified directly by varying E and δ at the same time in the same ratio. Hence, as $\frac{E}{\delta}$ (δ being small) is a measure of the density of the charge, or the electric forces at the surface of the plates, and in the medium which separated them, M. Stoletow concluded that the intensity of the actino-electric current is a function of this density [$C=f(\sigma)$], so that, making $\delta=1$, we shall have $C=\phi(E)$, the curve of which is analogous to the curves resulting from the experiments. This curve shows that C for small E.M.F.'s increases rapidly with σ, but when E becomes large, C seems to tend to a saturation limit.

To make sure that $\frac{E}{\delta}$ was a measure of the E.M.F.s between the plates during the passage of the actino-electric current, M. Stoletow investigated by means of the electrostatic method the fall of potential at this moment, and ascertained that this fall is always a linear function of the distance $\left[V=V_0+(V_1-V^0)\frac{x}{\delta}\right]$. The same method showed that the difference of potential between the plates did not change under the influence of light, so that owing to the enormous resistance $\left(\frac{E}{\delta C}\right)$ of the layer of air the discharge produced by the light was rapidly restored by the battery.

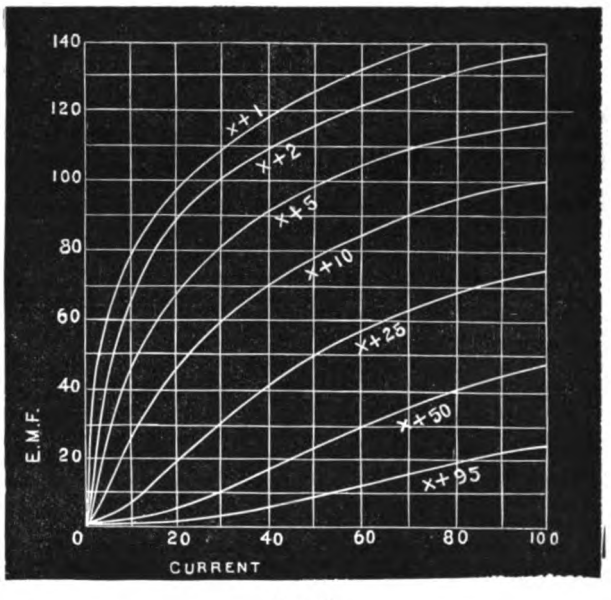


FIG. 2

The difference of potential of the plates is equal to the E.M.F. of the battery where the two metals are identical ; but if they are different it is necessary to add the E.M.F. of contact. The question then arises, does this E.M.F. take any part in actino-electric phenomena ? The apparatus was sensitive to ·01 of a Daniell, and M. Stoletow completely eliminated the battery from the circuit and charged his condenser merely by contact force. The experiment was completely successful, using silver as the negative plate, zinc as the positive plate. The system of zinc, air, and silver lit by the electric light thus became a veritable battery, in which the E.M.F. was furnished direct by the intensity of the light. M. Stoletow also measured the E.M.F. of Zn/Ag by the actino-electric current, and obtained a figure approximating very closely to those obtained by Pellat, Kohlrausch, and others. It would seem, therefore, that we have here a new galvanometric method of measuring this important constant.

Wishing to vary his experiments as much as possible, M. Stoletow effected his measurements by a method which consisted in charging a condenser of great capacity, and measuring the discharge current. Applying this method to the case in which his condenser was only charged by contact potential, M. Stoletow found that if the action of the light lasted longer than was necessary to discharge the negative electrode, the discharge current was stronger

Digitized by Google

than it ought to be. Hence it appears that the light not only discharges the electrode, but gives it a positive charge.

M. Stoletow does not give a theory concerning these phenomena, but, in his opinion, there is a great analogy between them and those of the discharge of gases in Geissler tubes. To him a condenser of this kind is nothing more than a Geissler tube, worked by an external source of light in a non-rarefied atmosphere.

ELECTRIC WELDING.*

BY C. E. HARTHAN.

During the present century only iron and steel, or possibly bronze, were considered weldable, and quite recently platinum. When we studied physics, we were taught that the weldable class of metals were iron, steel, and platinum, all others being unweldable, but now we can weld almost every metal known, and perhaps every metal. I know that every metal tried by the Thomson electric welding process has been welded satisfactorily. Prof. Thomson may therefore be credited with having introduced a universal method of welding. While he was preparing a lecture on physics before the Franklin Institute at Philadelphia, about twelve years ago, he made an experiment to illustrate the reversibility of an induction coil. The discharge of a Leyden jar and a Rhumkorff coil were used. While working with it, it occurred to him that it would be a very pretty experiment to reverse the process. This was done, and he was much astonished at the volume of current obtained: the ends of the primary were brought into contact and actually stuck firmly together. The experiment was repeated several times. The recent experiments of welding by electricity are the outgrowth.

When the Thomson-Houston Company and other electric companies commenced to manufacture dynamos, they could not get copper wire in lengths long enough to wind the armature with; the soldered joint was an objection, as it took time to make; the soldering acid would soak through the insulation and cause a short-circuit, and the result was a burned-out armature; and the loss of short pieces of heavy copper wire was considerable. The first welding apparatus worked very successfully, and welds made with it were put to practical use in the factory of the Thomson-Houston Company, such work as welding copper, iron and steel wire, joining short pieces of heavy copper wire, to be used in the series coil of the incandescent dynamo, welding Stubb's steel shanks to drills, taps, reamers, &c., welding band saws for pattern shop, lengthening bits for expert's use, lengthening brass rods, &c.

The Thomson process of electric welding, which might be called the incandescent method as contrasted with what is known as the arc method of electric welding, was first brought before the public at an illustrated lecture given by the president of this club before the Society of Arts, Boston, in December, 1886, where it was shown in working order with a lot of specimens. The process of arc fusing might be mentioned under the head of electric welding. In this process the direct current is used of sufficient potential to maintain an electric arc. The pieces to be joined are made one electrode and a piece of carbon or some suitable material is made the other. The carbon piece is first brought in contact with the pieces to be welded, then separated after the current has been turned on; by so doing the arc is obtained, then move along or about the joint to be made. The effect of the arc (the heat of which is very intense) is to melt the metal, but iron and steel and other metals are burned to a certain extent. I have seen some of the specimens, but did not call them at all satisfactory. They appeared to be very spongy, and small holes in them in some portions, shown to have been burned or very much overheated. They had no strength—seemed like rotten iron. The heat is applied in the wrong place, the current having been directly across the junction instead of through it as in the Thomson method. Serious difficulties are met with in keeping the arc the right length and fed along properly, which is done by hand. It is very trying to the eyes even when protected. Another difficulty is the regulation of the dynamo, although the storage battery is used.

In the construction of a welding coil care must be taken that there are no other circuits made elsewhere than in the welding circuit. There must also be about as much section of copper in secondary as total section of primary, or, in other words, the same number of ampere-turns in each. The joints in the welding circuits should be as few as possible, and what joints are made must be perfect in contact, as a poor contact means immense loss of energy by unnecessary resistance, as we are dealing with very low potential—about one or two volts—and very heavy currents. The core is made of laminated sheet iron discs bolted together, with hole in centre large enough for secondary and primary circuits. The primary consists of coils wound on a form and slipped on to the core through an opening which is afterwards filled with laminated phig. The secondary is often a heavy copper tube or bar passed through the centre of core, connected at the two ends with copper castings, connecting with welding clamps, and in such case the joint at the end is made on a taper set up tight to ensure contact with a nut, thread having been cut on end of copper bar. This whole is placed on a proper base, with a sort of table at the top which supports the clamps and pressure device. The clamps are usually made with one clamp kept stationary during welding and one movable clamp, the pressure power being obtained by a screw worked with a worm wheel or rachet.

The welding dynamos are all similar in form, but vary in size and connections. The form is of frame, with field-magnets projecting inward, having four and six field-poles made of separate plates of iron securely bolted together and to frame, the coils being slipped on in the ordinary way. The bearings are made self-oiling. The armature is a type of its own: it is a pole armature—that is, the core has four or six projections; the coils are wound on these. It cannot be called a drum armature, nor Pacinotti, nor Siemens, but perhaps a modification of the shuttle type. Perhaps the name multipolar Siemens shuttle might be suggested. The alternating current is taken off the collector rings in the ordinary way. The dynamos are divided into different classes—the two, four, and six-pole machine, also self-exciters, separate exciters (where fields are excited by small dynamos), and composite dynamo. They are generally wound for 300 volts, and run at a rate of 100 alternations per second, or 6,000 per minute. The four-pole machines are run at a speed of 1,500, the six-pole 1,000 per minute. As the dynamo is doing work only at short periods and not constantly, the output is much more than it otherwise would be for the same size of machine for continuous work. They are of much less weight for the same number of watts than an alternating lighting generator.

Some of the first questions asked by a person who has seen the welding for the first time are:—"How much power does it take? How strong are the welds? Can you weld all metals? How large can you weld?" &c., &c. Horse-power required is an important factor in some cases, or where power is limited; but in cases where joints cannot be made by any other process, power is not so much a question, or where power is in abundance and easy of access, such as water power. Here a difficult task was met with. Instruments are not made to measure such heavy currents; even if they were, they could not be introduced in the welding circuit or secondary conductor of the welder, as it is so very short—only a few inches long. So instruments had to be constructed for the purpose, and the horse-power has been measured in more ways than one. Something over a year ago a series of power tests were made by means of the calorimeter. The result of tests made this way show that the average power consumed in a ½in. bar of iron welded is about 6½ horse-power, welded in 10 seconds; 1in. round iron, 12 horse-power, welded in 40 seconds; 1½in. round iron, 18 horse-power, welded in 90 seconds. Probably these results are not absolutely correct, as they were obtained from a very crude apparatus, but I think they are within 10 per cent. Comparison of different results shows that from 65 to 72 per cent. of the total energy of the engine is consumed in the weld.

The time taken in making a weld is a very important factor, as the quicker the weld is made the more power is consumed for the time. If a piece of 1in. round iron is welded in 40 seconds, and requires 20 horse-power, it would require about twice the power to do the same work in one-half the time, or about one-half the power in twice the time. This theory holds good within a wide range, perhaps 30 or 40 per cent each way from the table just given. If a weld is made too quickly, the metal is burned at the ends in contact; if made too slowly, the machine and clamps are over-heated, and energy is lost by radiation of heat.

The distance between the clamps is another factor; the less projection of the piece beyond the clamps the less power is used, as the resistance through the bar is lessened, but, as the pieces become heated to high temperature, the clamps absorb the heat, and are also burned if too close. If too great projection is given much power may be lost from radiation. and a longer length of bar will be heated than is necessary. For heavy work, and that done continuously, it is found necessary to employ a method, already worked out in early welding patents, to keep the clamps cool: this is done by having them constructed with water circulating round them. The fact that the resistance increases as the temperature increases is a great benefit in welding, as the bar heats at the ends in contact on account of the high resistance, also heats more at heated portions on account of increasing resistance, thereby localising the heated portion of the bar during the welding operation. By continued experiment the best results, everything taken into account, are when the projection beyond each clamp is a certain relation to the diameter of the stock—that is, for round bars of iron.

It is often asked how much current does it take to weld a bar of iron, &c.? This depends on the time in which it is done, &c. As the potential is very low, only one or two volts, the amperes are

* Lecture before the Thomson Scientific Club, Lynn, Mass.

Digitized by Google

reckoned in the thousands. For a 1in. round iron about 5,000 amperes in 40 seconds; for a 2in. round iron about 20,000 amperes in 80 seconds.

This electric welding process has become so universally known that the general public expect almost too much from it. It surely is a great invention and a very important one, but still there is much work of development for special cases to be done; and as to size of piece, the limit may be reached some time, but it has not as yet been reached. It is expected by some people that everything can be welded by the electric current. That is expecting too much, but nearly every kind of metal can be welded. Among the metals that have been welded are: gold, platinum, silver, copper, aluminum, bismuth, cobalt, antimony, zinc, tin, lead, iron, nickel, magnesium and manganese. Among the alloys welded are: the different kinds of brass and bronze, phosphor bronze, aluminum bronze, silicon bronze, numerous grades of steel, cast iron, malleable cast iron, German silver, lead alloys, tin and lead, and others. Among the combinations of different metals are: copper to brass, brass to iron or steel, brass to German silver, German silver to iron or steel, nickel to iron, iron to steel, cast iron to wrought iron, German silver to copper, lead to tin, tin to zinc, brass to tin, gold to silver, gold to platinum, silver to platinum. Prof. Thomson has a welded bar three-eighths of an inch in diameter made of different metals, nine pieces. It is made up in the following order: copper, brass, iron, German silver, brass, tin, zinc, tin and lead. A similar bar was sent to the Paris Exhibition.

As to the strength of these welded bars, an inspection of the report of tests made on the Rich testing machine, the property of the Company, at their factory, shows that wrought iron may be welded to stand the same tensile strength as the unwelded bar. When a perfect weld is made the fracture is usually within the heated portion of the bar, caused by the stock being annealed at that section. If a welded bar breaks at the weld it is no sign the weld was a poor one, so long as the tensile strength is up to the standard. If the weld by the ordinary blacksmith process stands 70 per cent. or 75 per cent. of original stock it is called excellent. We are not satisfied unless as high as 85 per cent. is reached with the burr removed. Hammering the weld lightly at the welding heat gives it more strength; 95 per cent. and even 100 per cent. is then reached, and, of course, if the piece break some way from the weld the joint is much more than 100 per cent. Wrought-iron bar stands about 50,000lb. per square inch. Norway iron bar stands about 60,000lb. per square inch. Mild steel may be welded without difficulty. Tool steel is also welded without much trouble. Tool steel welds are not as strong usually as the unwelded bar, although the percentage is pretty high, the average being from 80 per cent. to 85 per cent. of annealed stock. Yet these joints are vastly stronger than the same area of wrought iron. Tensile strength of mild steel is from 60,000 to 80,000lb. per square inch. Tensile strength of tool steel is from 75,000 to 120,000lb. per square inch, and even higher. The strength of a tool steel weld is greatly improved by light hammering while at the welding heat if properly done. The welding heat of steel is far below that of iron, so, therefore, in welding steel, more pressure is required than with iron to effect the weld, because the steel is not so plastic and soft as iron while hot. The limit between the burning point and non-welding point is very small, so it is an easy matter not to effect a good weld. But after a little practice, with care it is welded without difficulty. The higher grades of cast steel require as much real care to effect a good weld as anything dealt with. The heat produced by the current of electricity is not materially different from the heat of a forge, fire, or gas flame, but it is developed in the bar from the inside, not outside. Iron will weld if pressure is applied and sufficiently high temperature is reached, it matters not how heated, whether by electricity or otherwise, but we get the avoidance of dirt and impurities. We also get the avoidance of irregular heat in the two pieces. Also by this method only a limited mass is heated. It is not known if the current has any effect in assisting the union in addition to its heating effect. Iron and steel are welded together readily and with very good results in regard to tensile strength, the fracture usually occurring in the iron. Copper is welded very readily, and with substantially the same strength as original annealed stock. Copper is annealed at the section of the weld, but is easily toughened by rolling or drawing. Tensile tests of welded copper show 90 to 98 per cent. of annealed stock. The conductivity of welded copper shows 100 per cent. as compared with unwelded copper: this can also be said of phosphor bronze and silicon bronze, as used in the electric railway. The tensile strength of annealed copper is about 32,000lb. per square inch. Wrought brass is welded without difficulty. The percentage of tensile strength is very high. The tensile strength of annealed brass is about 47,000lb. per square inch. Very good joints are made between brass and iron. The fracture is usually of an irregular nature, sometimes in the brass, but usually at the weld. Iron and steel chains are welded with very good results. Chains are usually made (by this process) with a double weld in each link, or a weld at each side. Chains have been welded and tested in sizes from $\frac{1}{16}$ wire to 1in. round iron. Chains made from $\frac{1}{16}$ wire stand a strain of 260lb. Chains made from bar of $\frac{1}{16}$ iron stand a strain of 130lb., or 40,600 lb. per square inch. This chain stood 200 per cent. of a single wire of same material annealed. A chain of $\frac{1}{8}$ wire stands a strain of 1,180lb. A chain of $\frac{1}{8}$ iron bar stands a strain of 790lb., or 61,500lb. per square inch. This chain stood 150 per cent. of a single wire of same material. A chain of $\frac{1}{2}$in. round steel stands a tensile strength of 22,000lb. A bar of 1in. round steel stands a tensile strength of 15,000lb. This chain stood 147 per cent of single bar of same material. A chain of 1in. round iron stands tensile strength of 65,400lb. A bar of 1in. round iron stands tensile strength of 38,000lb. This chain stood 172 per cent. of a single bar of same material. The reasons why a chain does not stand twice the tensile strength of one solid bar of same material are several. There is a shearing strain at the end of link, also a bending strain, as the link is lengthened by pulling. The fracture is usually at the end of the link, or just one side, between the weld and the end of the link.

The variety of uses to which this method applies is unlimited and too numerous to mention to-night; but now that I have given an idea of what the Welding Company has done and is doing at the present time, it may, perhaps, be of interest to say something as to what they may do at some future time. Probably there is no invention which covers such a broad field of work with such a variety and kinds of work. The business of constructing and supplying the necessary appliances must grow to be very large. It will not be confined to the United States, but will be open to foreign countries in all parts of the world. It is now represented in the United States, Canada, England, Scotland, Belgium, and France. It would be useless to try to name the various uses this could be applied to, but a brief and incomplete statement of some of the uses might convey some idea in a small way: Rod and bar welding up to 6in. or 10in., or more; joining bars of different shape and section; welding and laying sections of railroad track; welding and putting up conductors for electrical purposes; making joints at angles with bars as T or Y joints; pipe work, welding, brazing, soldering, elbows; T joints, &c., for non-leaking pipes, such as natural gas or oil pipe lines, boiler tubes, &c.; working, joining, &c., of lead pipe, chain and link work, from smallest jeweller's work to heavy "2" iron ship cable, or more. Much of these kinds of work will probably be accomplished by automatic machines. Endless rings, hoops, and tires, from finger rings of precious metals to heaviest iron or steel bands imaginable; tool construction in great many forms, from steel points on mathematical instruments of German silver, &c., to steel edges of heavy cutting tools; construction and building of machinery, such as constructing parts of firearms, dentist tools, carriage and waggon work, locomotive frames, ship machinery, &c.; shaping in great variety of ways by revolving pieces kept hot by electric current; boiler work, riveting, brazing, soldering, &c.; bridge work, riveting, brazing, and forming; ornamental iron work, such as fences, &c. In the heavy machines of the future the construction will be mechanically different, an attempt being made to get better and better efficiencies from the coil. It will be desirable for heavy work to construct hydraulic pressure devices and hydraulic clamping devices, with cooling devices; also cranes for handling such work. Where hammering is beneficial, an electric hammer to operate by means of electric current has been planned. But the details of the future cannot be dealt with, so we will close, and trust the Welding Company may successfully meet the demands of future growth and prosperity.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

SATURDAY, December 28th.

ROYAL INSTITUTION.

3 p.m. Lecture: "Electricity." By A. W. RÜCKER, M.A.

MONDAY, December 30th.

LONDON INSTITUTION.

4 p.m. Lecture: "Soap Bubbles, and the Forces which Mould Them." By C. V. BOYS, F.R.S.

TUESDAY, December 31st.

ROYAL INSTITUTION.

3 p.m. Lecture: "Electricity." By A. W. RÜCKER, M.A.

WEDNESDAY, January 1st, 1890.

LONDON INSTITUTION.

4 p.m. Lecture: "Soap Bubbles, and the Forces which Mould Them." By C. V. BOYS, F.R.S.

SOCIETY OF ARTS.

7 p.m. Juvenile Lecture I.

THURSDAY, January 2nd.

INSTITUTION OF CIVIL ENGINEERS.

2 p.m. Students' visit to Messrs. Maudslay's Works, 110, Westminster-bridge-road, S.E., and subsequently to Bryn's Oxygen Works, 69, Horseferry-road, S.W.

ROYAL INSTITUTION.

3 p.m. Lecture: "Electricity." By A. W. RÜCKER, M.A.

Digitized by Google

The Electrician.

Published every Friday. Price Fourpence; Post Free, Fourpence Halfpenny.
Editorial, Publishing and Printing Offices:

No. 1, SALISBURY COURT, FLEET STREET, LONDON, E.C.

Telephone No. 2714. Telegrams: "ELECTRICIAN NEWSPAPER, LONDON."

All Communications to be addressed to "THE ELECTRICIAN," *1, Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN."

All letters intended for insertion in "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. Subscribers should receive their copies by the first post on Friday morning.*

"THE ELECTRICIAN" *is on sale at the railway bookstalls throughout the United Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices as above.*

SPECIAL NOTICE.

Owing to the increase in the number of pages of "THE ELECTRICIAN," in order to partly cover the increased postage, we have been compelled to revise the rates for Foreign Subscriptions, which are now as follows:—

	3 months.	6 months.	12 months
For Foreign Parts and Colonies:—	s. d.	s. d.	s. d.
Within Postal Union	6 6	12 6	24 0
Aden, Borneo, Ceylon, China, India, Japan, Java, Labuan, Mozambique, New Caledonia, Persia, Philippine Islands, Siam, Transvaal, and Zanzibar	7 6	14 6	28 0
The rates for the United Kingdom remain as follows:—	5 0	10 0	19 6

TO ADVERTISERS.

"THE ELECTRICIAN" *offers exceptional advantages to Advertisers.* **It has the largest circulation of any English Electrical paper, and circulates all over the World.**

Particulars relating to Advertisements will be promptly forwarded on application to the office.

TRADE ADVERTISEMENTS *intended for the current issue must be handed in not later than First Post on Thursday morning.*

SMALL PREPAID ADVERTISEMENTS *(for Rates see page xiii.) are accepted up to 4:30 p.m. on Thursday.*

TECHNICAL PRINTING.

"THE ELECTRICIAN" PRINTING AND PUBLISHING COMPANY (LIMITED) *beg to inform Electricians, Electric Light Engineers, &c., that they make a specialty of Technical Printing, and have a Staff thoroughly acquainted with Electro-Technology. They can, therefore, promise Accuracy and Despatch in the Printing of Electrical Catalogues and Electro-Technical Literature generally.*

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.

Royal 8vo.

Early in each year is issued "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK. *The* DIRECTORY *was established in 1883, and the 1889 Edition consisted of more than 600 pages of printed matter. The names and addresses of all persons engaged in the Electrical Industries may be relied upon as accurate. Useful Tables and Electrical Formulæ, and information specially compiled for this work are given, together with popularly-written Biographical Notices of the leading Electricians, Electrical Engineers, &c., accompanied in many cases by Portraits.*

The issue for 1890, which will be still further enlarged and improved, is in active preparation. New Names and Addresses, Corrections, Advertisements, &c., should be forwarded at once to the Publishing Office, 1, *Salisbury-court, Fleet-street, London, E.C.*

CONTENTS OF THE CURRENT NUMBER.

NOTES 181
The Underground Mains of the Hastings Electric Light Company 186
Sir William Thomson's New Inspectional Electric Instruments. Illustrated 187
The "New Century" Electric Motor. Illustrated 188
The Actino-Electric Researches of M. Stoletow. Illustrated.. 188
Electric Welding. By C. E. Harthan 190
Meetings of Scientific Societies. 191
THE ART OF INSULATION 192
Reviews 194
On the Heating of Conductors by Electric Currents. By A. E. Kennelly. Illustrated. Concluded 194
The Newall High-Speed Engine. Illustrated 196
The Edinburgh Exhibition, 1890 198
American Notes 198
CORRESPONDENCE—
The Electric Light in English Towns.—C. H. Y. 199
Photographing St. Elmo's Fire.—T. Arnall 199
The Hookham Meter Action.—Montagu J. Scott and Co. 199
The Heating of Conductors. H. Human 199
Flames and Electricity.—J. Johnstone 200
Trade Notes and Notices 200
Scott Instantaneous Fuse.—Illustrated 201
PATENT RECORD 201
Books Received 201
Co-Operative Telephones 201
COMPANIES' MEETINGS, &c.—
Metropolitan Electric Supply Company (Limited) 202
The Phonopore Syndicate ... 205
New Companies Registered ... 205
City Notes, &c. 205
Companies' Share List 206

THE ART OF INSULATION.

To protect an electric conductor efficiently, so that under no circumstances electricity shall escape from it by an undesired route, is an art not to be acquired without both knowledge and experience. Knowledge of the laws and properties of electricity, experience in their application to the circumstances of the case, and, as a *tertium quid*, sound conscientious workmanship in execution—these three go to the art of insulation. Nor must a certain amount of mechanical engineering be forgotten, since efficient insulation depends in almost every case upon the selection of materials which shall be both mechanically and electrically adapted for the purpose which they are to serve.

Since the days when STEPHEN GRAY made the momentous discovery that an electric discharge, though it could pass along a metallic wire or a damp hempen thread, would not flow along a silken cord, it has been customary to classify materials into two classes, conductors and non-conductors. No one, however, has been able quite to say at what point the one class ended and the other began, since they merge into each other. But in view of the fact that some of the so-called non-conductors do not become appreciably conductive, even under extremely great electric pressures, these excessively resisting substances have been used for the purpose of protecting electric conductors from leakage, and so have become known as insulators. Some writers have classified insulating materials under three classes—the stony and vitreous bodies, such as porcelain, glass, mica, and asbestos; the resinous, gummy, and fatty bodies, such as shellac, gutta-percha, indiarubber, ozokerit, wax, paraffin, and the oils generally; and lastly, gaseous bodies, such as the air. The brown stoneware insulators which support our telegraph wires are as familiar objects to the British citizen as the blue glass insulators that do similar duty in the States are to the American. Each is characteristic of the climate in which it has proven fittest; each represents not only ingenuity and invention, but a vast amount of experience. The very familiar mode of protecting the copper wire used in the coils of electro-magnets and galvanometers, by serving it with a coating—single, double, or even triple—of cotton or silk, represents likewise the result of experience and ingenuity. In earlier days, before covered wire was an article of commerce, experimenters used to insulate the wires of their

Digitized by Google

LAURENCE, PARIS & SCOTT, Ltd.

Gothic Works, King St., NORWICH.

PERFECT MECHANICAL CONSTRUCTION. HIGH EFFICIENCY.

Tel. Address, "Gothic Norwich

HIGHEST AWARD BIRMINGHAM ELECTRICAL EXHIBITION.

DYNAMOS & MOTORS.

CONTINUOUS CURRENT TRANSFORMERS.

PATENT IMPROVED UNDERGROUND MAINS.

PATENT INSTANTANEOUS FUSES.

BEST WORKMANSHIP. MODERATE PRICES.

Tel. Address, "Gothic Norwich.'

THE GENERAL ELECTRIC CO., Ltd. (G. BINSWANGER, Managing Director.)

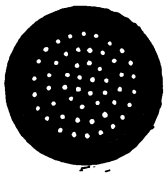
(OF LONDON AND MANCHESTER)

TELEGRAMS "ELECTRICITY."] **71, Queen Victoria Street, LONDON, E.C.** [TELEPHONE No. 1887

MANUFACTURERS AND SUPPLIERS OF ALL ELECTRIC LIGHT FITTINGS AND MATERIAL.

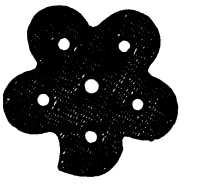
BEST. CHEAPEST.

"APOSTLE" ELECTRIC LIGHT CARBONS.



Lead Covered Cables, Anti-Induction and Bunched for Underground, Submarine and Aerial, Telephone, Telegraph, Electric Light, and Power.

THE FOWLER-WARING CABLES COMPANY, LTD.



85, QUEEN STREET, LONDON, E.C.

F. WIGGINS & SONS, Telephone No. 2248. } 10, Tower Hill, E., and 102, Minories, London, E.C.

Manufacturers of MICA GOODS for PHILOSOPHICAL and ALL PURPOSES.

CONTRACTORS TO HER MAJESTY'S GOVERNMENT.

MICA

ELECTRIC TRAM-CARS.

37,000 Miles Already Run.

DAILY AVERAGE 300 Miles,

Running on the BABKING ROAD, E., FOR THE

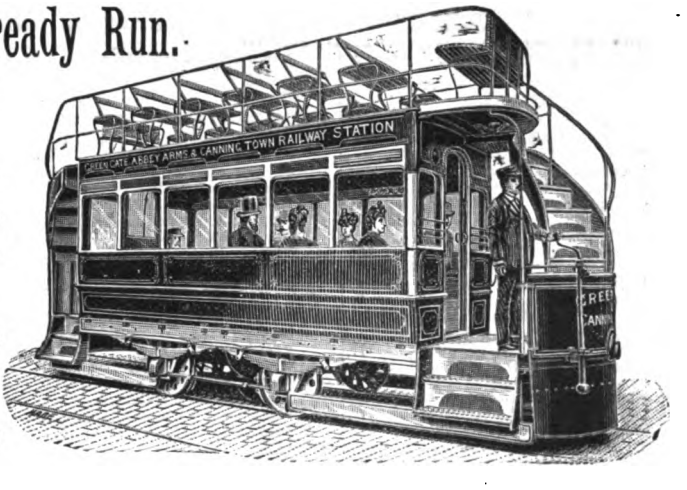
NORTH METROPOLITAN TRAMWAYS CO., LTD.

Everyone should see these Cars. Certain to supplant horse and every other form of traction.

Full particulars from the SECRETARY,

ELECTRIC TRACTION CO., Ltd.,

NEW BROAD STREET HOUSE, LONDON, E.C.



Digitized by Google

"THE ELECTRICIAN" INDEX TO ADVERTISERS.

Advertisers in "The Electrician" have their names inserted under the following headings in this Index FREE OF CHARGE.

ACCUMULATORS. PAGE
Drake and Gorham — —
Electrical Power Storage Co. .. 20
ACIDS.—Berk (F. W.) and Co. 18
ALTERNATORS.
Brush Electrical Eng. Co. (Ltd.).. 6
Johnson and Phillips 1
AMMETERS.
Acme Electric Works'..... 18
Goolden (W. T.) and Co..... 11
Nalder Bros. and Co. 8
Sharp and Kent..... —
ANTI-FOULING COMPOSITIONS.—Kirkaldy (J.) and Son. 19
ARC LAMP BLOCKS.
Joyner (Chas.) and Co. ..... —
ASBESTOLINE.
Bell's Asbestos Company 24, 25
AUCTIONEERS AND VALUERS (Mechanical).
Wheatley Kirk, Price and Goulty 3
B.A. SCREW THREAD.
Lehmann (Th.) 3
BATTERIES.
Fowler, Lancaster and Co..... 3
Gent and Co. ..... —
India Rubber & Gutta Percha Co. 14, 18
Johnson and Phillips 1
Laing, Wharton and Down ... 9, 17
Latimer Clark, Muirhead & Co. 1
BATTERY JARS.
Joseph Bourne and Son 17
Cannington, Shaw and Co..... 2
Gent and Co. ..... —
Price, Sons and Co. ..... —
Stiff (J.) and Sons 3
BELTING.
Balderston and Co. ..... —
Moseley and Sons ..... —
Thompson (N. G.) ..... —
Willcox (W. H.) and Co..... —
BRIDGES (WHEATSTONE).
Woodhouse & Rawson United, Ltd 7
CABLE COMPANIES.
African Direct Telegraph Co. .. 26
Anglo-American Telegraph Co. 29
Brazilian Submarine Tel. Co. .. 27
Direct United States Co..... 29
Eastern Telegraph Co..... 30
Eastern Extension Telegraph Co. 30
Eastern & South African Tel. Co. 26
Indo-European Co. 28
West African Telegraph Co..... 26
Western and Brazilian Tel. Co... 27
CABLE SUPPLIES.
Latimer Clark, Muirhead & Co... 1
Elliott Brothers 19
Felten and Guilleaume 1
Fowler-Waring Cables Co. (Ltd.) 15, 19
W. T. Glover and Co. 17
W. T. Henley's Teleg. Works Co. 1
India Rubber & Gutta Percha Co. 14, 18
Johnson (E.) and Nephew ..... —
Johnson and Phillips 1
Pirelli and Co. ..... —
Telegraph Manufacturing Co. .. 2
M. Theller and Sons 13
CARBONS.
Brush Electrical Eng. Co. (Ltd.).. 6
Chamberlain (H. and F.) 3
General Electric Co. 15
India Rubber & Gutta Percha Co. 14, 18
Johnson and Phillips 1
Laing, Wharton and Down ... 9, 17
Thompson (N.G.) (Carré) ..... —
Woodhouse & Rawson United, Ltd. 7
CASINGS.
Acme Electric Works 18
Garrard (Robert) and Co. ..... —
McGaw and Co. 11
CONDUITS.—Johnson & Phillips 1
CUT-OUTS.
Acme Electric Works 18
Dorman and Smith 17
General Electric Co. 15
Laurence, Paris and Scott (Ltd.) 15, 17
Wolverhampton Electrical Co... 2
Wood (W.) and Co. ..... —
Woodhouse & Rawson United, Ltd. 7
DISINFECTANTS.—Sanitas Co. 18
DYNAMO BRUSHES.
F. H. Royce and Co..... 13
DYNAMO MANUFACTURERS.
Allen and Co. ..... —
Brush Electrical Eng. Co. (Ltd.).. 6
Latimer Clark, Muirhead & Co.. 1
Crompton and Co. (Limited).... 14
Edison & Swan United Elec. Lt. Co. 5
Fowler, Lancaster and Co..... 3
Gülcher Electric Lt. & Power Co. 10
W. T. Henley's Teleg. Works Co. 1
Holmes (J. H.) and Co. 4
M. Immisch..... 8
India Rubber & Gutta Percha Co. 14, 18
Johnson and Phillips 1
Laing, Wharton and Down ... 9, 17
Laurence, Paris and Scott (Ltd.) 15, 17
Paterson and Cooper 17
Sharp and Kent..... —
Statter and Co. 17
Telegraph Manufacturing Co. .. 2
Thompson (N. G.)..... —
United Electrical Engineering Co. 206
Western Electric Co. 10
Zöpke (F.)... 3
EBONITE & VULCANITE. PAGE
Harburg India-Rubber Comb Co. —
D. Moseley and Sons ..... —
EDUCATIONAL.
School of Electrical Engineering —
ELECTRIC BELLS.
Acme Electric Works 18
General Electric Co. 15
Gent and Co. ..... —
India Rubber & Gutta Percha Co. 14, 18
Johnson and Phillips 1
King, Mendham and Co. ..... —
London Electric Wire Co. 17
Julius Sax 17
Sheppard, Allarton & Madeley.. —
Telegraph Manufacturing Co. .. 2
Western Electric Co. 10
Woodhouse & Rawson United, Ltd. 7
ELECTRIC LIGHT.
Bernstein Electric Lamp Co..... 2
Brush Electrical Eng. Co. (Ltd.).. 6
Latimer Clark, Muirhead & Co. 1
Crompton and Co. (Limited).... 14
Drake and Gorham..... —
Edison & Swan United Elec. Lt. Co. 5
Electrical Power Storage Co. .. 20
Fowler, Lancaster and Co..... 3
Gent and Co. ..... —
Gülcher Elec. Light & Power Co. 10
W. T. Henley's Teleg. Works Co. 1
India Rubber & Gutta Percha Co. 14, 18
Johnson and Phillips 1
King, Mendham and Co. ..... —
Laing, Wharton and Down (Thomson-Houston) 9, 17
Paterson and Cooper 17
Statter and Co. 17
United Electrical Engineering Co. 206
Woodhouse & Rawson United, Ltd. 7
ENGINEERS & CONTRACTORS
Acme Electric Works 18
Bernstein Electric Lamp Co.... 2
Blenheim (W.) and Co. ..... —
Booth, Ellson and Co. 18
Brush Electrical Eng. Co. (Ltd.).. 6
Latimer Clark, Muirhead & Co. 1
Chamberlain and Hookham 11
Crompton and Co. (Limited).... 14
Drake and Gorham ..... —
Edison & Swan United Elec. Lt. Co. 5
Electrical Power Storage Co. .. 20
Fowler, Lancaster and Co..... 3
W. T. Henley's Teleg. Works Co. 1
India Rubber & Gutta Percha Co. 14, 18
Johnson and Phillips 1
King, Mendham and Co. ..... —
Laing, Wharton and Down ... 9, 17
Laurence, Paris and Scott (Ltd.) 15, 17
Nalder Bros. and Co. 8
Paterson and Cooper 17
Phillips Bros. 17
Julius Sax 17
Sharp and Kent ..... —
Shippey Brothers (Limited) .... —
Starnes (J. S.) and Sons 8
M. Theller and Sons 13
Thompson (N. G.)..... —
United Electrical Engineering Co. 206
Verity (B.) and Sons 10
Westinghouse Electric Company 2
Woodhouse & Rawson United, Ltd. 7
ENGINE PACKING.
Bell's Asbestos Company 24, 25
Starnes (J. S.) and Sons 8
Willcox (W. H.) and Co..... —
ENGINES.
Bailey (W. H.) and Co. (Limited) 12
Bumsted, F. D. 8
Crossley Bros. 22
Davey, Paxman and Co. 14
Marshall, Sons and Co..... 3
Priestman Bros. (Limited)..... —
Ransomes, Sims and Jefferies .. —
Richards and Co. 12
Robey and Co. 4
Statter and Co. 17
Willans and Robinson..... —
EXCESS ALARMS.
Drake and Gorham ..... —
EXPANSION SHEETING AND RINGS.
Bell's Asbestos Company 24, 25
FENCING.—R. Johnson & Nephew —
FIBRE.—Moseley (D.) and Sons .. —
FIRE RISKS.—Phœnix Fire Office —
FITTINGS for ELECTRIC LIGHT
Acme Electric Works 18
Crompton and Co. (Limited).... 14
Dorman and Smith 17
Evered and Co. (Limited) ..... —
General Electric Co. 15
Gent and Co. ..... —
Gülcher Elec. Light & Power Co. 10
Johnson and Phillips 1
King, Mendham and Co. ..... —
Laing, Wharton and Down..... 9, 17
Telegraph Manufacturing Co. .. 2
United Electrical Engineering Co. 206
Verity (B.) and Sons 10
Western Electric Co. 10
Wolverhampton Electrical Co... 2
Wood (W.) and Co. ..... —
Woodhouse & Rawson United, Ltd. 7
Zöpke (F.)..... 3
FUSES.
Fowler, Lancaster and Co. 3
GLASSWARE.
Acme Electric Works 18
GALVANOMETERS. PAGE
Nalder Bros. and Co. 8
GAS LIGHTERS (ELECTRIC).
General Electric Co. 15
King, Mendham and Co. ..... —
Woodhouse & Rawson United, Ltd. 7
GLOBES.—Fowler, Lancaster & Co. 3
GYROMETER (Speed Indicator).
Bailey (W. H.) and Co. (Limited) 12
INDIA RUBBER.
Moseley (D.) and Sons..... —
Pirelli and Co. ..... —
INFLUENCE MACHINES.
King, Mendham and Co. ..... —
INSTRUMENTS.
Acme Electric Works 18
Latimer Clark, Muirhead & Co. 1
Crompton and Co. (Limited).... 14
Elliott Brothers..... 19
General Electric Co. 15
India Rubber & Gutta Percha Co. 14, 18
Johnson and Phillips 1
King, Mendham and Co. ..... —
Nalder Bros. and Co. 8
Paterson and Cooper..... 17
Sharp and Kent ..... —
Statter and Co. 17
Telegraph Manufacturing Co. .. 2
M. Theller and Sons 13
Woodhouse & Rawson United, Ltd. 7
INSULATION.
Aspinall's Enamel ..... —
Johnson and Phillips 1
INSULATORS.
Joseph Bourne and Son 17
Latimer Clark, Muirhead & Co. 1
W. T. Henley's Teleg. Works Co. 1
India Rubber & Gutta Percha Co. 14, 18
Johnson and Phillips 1
Price, Sons and Co. ..... —
Stiff (J.) and Sons 3
Telegraph Manufacturing Co. .. 2
IRON ROOFS & BUILDINGS.
Fredk. Braby and Co. (Ltd.) 23
Francis Morton & Co. ..... —
IVORY LABELS.
Endolithic Ivory Co. 13
JABLOCHKOFF'S DISTRIBUTION PATENT 206
LAMPS.
Bernstein Elec. Lamp Co. (Inc.).. 2
Brush Electrical Engineering Co. (Ltd.) (Arc and Incandescent). 6
Crompton and Co. (Limited).... 14
Dorman and Smith 17
Edison & Swan United Electric Light Co. (Incandescent) 5
Fowler, Lancaster and Co..... 3
Gülcher Electric Lt. & Power Co. 10
Holmes (J. H.) and Co..... 4
Johnson and Phillips (Arc) 1
Laing, Wharton & Down (Edison & Swan) 9, 17
Statter and Co. (Arc) 17
Sunbeam Lamp Co. 4
United Electrical Engineering Co. 206
Western Electric Co. (Arc)..... 10
Wolverhampton Electrical Co... 2
Woodhouse & Rawson United, Ltd. 7
Zöpke (F.)..... 3
LIGHTNING CONDUCTORS.
Gent and Co. ..... —
Johnson and Phillips 1
King, Mendham and Co. ..... —
Julius Sax 17
LUBRICANT.
Bell's Asbestos Company 24, 25
Willcox (W. H.) and Co..... —
MANUFACTURING ELECTRICIANS.
Acme Electric Works 18
Latimer Clark, Muirhead & Co.. 1
Dorman and Smith 17
Drake and Gorham ..... —
Elliott Brothers..... 19
General Electric Co. 15
Gent and Co. ..... —
W. T. Henley's Teleg. Works Co. 1
India Rubber & Gutta Percha Co. 14, 18
Johnson and Phillips 1
King, Mendham and Co..... —
Nalder Bros. and Co. 8
Paterson and Cooper..... 17
Julius Sax 17
Telegraph Manufacturing Co. .. 2
M. Theller and Sons 13
United Electrical Engineering Co. 206
Westinghouse Electric Company 2
Woodhouse & Rawson United, Ltd. 7
MEDICAL APPARATUS.
General Electric Company..... 15
METERS (ELECTRICITY).
Chamberlain and Hookham 11
MICA.—F. Wiggins and Sons 15
MOTORS (ELECTRIC).
Brush Electrical Eng. Co. Ltd.).. 6
Cuttriss and Co. ..... —
Goolden (W. T.) and Co..... 11
Gülcher Electric Lt. & Power Co. 10
Holmes (J. H.) and Co..... 4
M. Immisch..... 8
Laurence, Paris and Scott (Ltd) 15, 17
NON-CONDUCTING COMPOSITION.
Bell's Asbestos Company 24, 25
OIL CLEANER. PAGE
Woodhouse & Rawson United, Ltd. 7
PATENT AGENTS.
Berg (E.) ..... —
Chapman (J. C.) 28
PAINT, &c.
Indestructible Paint Co. 28
PLATINA SCRAPS.
Jamieson (W. & J.) 2
PRINTING AND ENGRAVING.
Waterlow and Sons (Limited) .. 10
POROUS CELLS.
Joseph Bourne and Sons 17
Price, Sons and Co. .. .. —
Stiff and Sons..... 3
PUBLICATIONS.
"The Electrician" Electrical Trades' Directory..... 21
Telegraph Convention Codes .. 17
Woodhouse & Rawson United, Ltd. 7
PULLEYS.—Richards and Co. .. 12
RESISTANCE COILS.
King, Mendham and Co. ..... —
Nalder Bros. and Co. 8
SECOHMMETER.
Nalder Bros. and Co. 8
SECONDARY BATTERIES.
Drake and Gorham ..... —
Electrical Power Storage Co..... 20
SHEET IRON.
Baldwin (E. P. and W.) 17
SOCKETS.—General Electric Co.. 15
SUPPLIES FOR CABLE SHIPS.
Lack (F.) and Sons 28
Starnes (J. S.) and Sons 8
Duncan Wallet and Co. 28
SWITCHES.
Acme Electric Works 18
Crompton and Co. (Limited).... 14
Dorman and Smith 17
Drake and Gorham ..... —
Edison & Swan United Elec. Lt. Co. 5
Fowler, Lancaster and Co..... 3
General Electric Co. 15
Holmes (J. H.) and Co..... 4
Sharp and Kent .. .. —
Thompson (N. G.)..... —
United Electrical Engineering Co. 206
Verity (B.) and Sons..... 10
Wolverhampton Electrical Co... 2
Wood (W.) and Co. ..... —
Woodhouse & Rawson United, Ltd. 7
TELEGRAPH ENGINEERS.
Acme Electric Works 18
Latimer Clark, Muirhead & Co.. 1
Elliott Bros. 19
W. T. Henley's Teleg. Works Co. 1
India Rubber & Gutta Percha Co. 14, 18
Johnson and Phillips 1
Telegraph Manufacturing Co. .. 2
TELEGRAPH PAPERS.
Waterlow and Sons (Limited) .. 10
TELEPHONES.
Blenheim (W.) and Co. ..... —
Fowler, Lancaster and Co..... 3
Gent and Co. ..... —
Stanhope Company 11
M. Theller and Sons 13
TOOLS.—Fenn and Co. ..... —
TRANSFORMERS.
Gülcher Elec. Light & Power Co. 10
Johnson and Phillips 1
Sharp and Kent ..... —
TUBES, &c.
Spencer (John) 3
TURNER.—Samuel Elliott 8
TYPE-WRITING.
Richardson (W. J.) and Co..... 18
VALVES.—Mosses and Mitchell .. 205
VENTILATING ENGINEERS.
Blackman Ventilating Company. 3
VOLTMETERS.
Acme Electric Works 18
Drake and Gorham ..... —
Edison & Swan United Electric Light Co. 5
Goolden (W. T.) and Co..... 11
Nalder Bros. and Co. 8
Sharp and Kent..... —
VULCANISED FIBRE.
Mosses and Mitchell..... 205
VULCANITE.
Harburg India-Rubber Comb Co. —
Moseley (D.) and Sons ..... —
North British Rubber Co. 19
WIRE (Covered or Uncovered).
Latimer Clark, Muirhead & Co.. 1
Felten and Guilleaume 1
Fowler-Waring Cables Co., Ltd. 15, 19
W. T. Glover and Co. 17
W. T. Henley's Teleg. Works Co. 1
Johnson (E.) and Nephew ..... —
Johnson and Phillips 1
Laing, Wharton and Down 9, 17
London Electric Wire Co..... 17
Midland Electric Wire Co. .... —
Phillips Bros. 17
Phosphor Bronze Company 204
Pirelli and Co. ..... —
Telegraph Manufacturing Co. .. 2
Western Electric Co. 10
WIRE-COVERING MACHINES.
Barraclough and Co. 2
Johnson and Phillips 1
WIRE-TESTING APPARATUS.
Woodhouse & Rawson United, Ltd. 7
WOOD.—Garrard (Robert) and Co. —

Digitized by Google

E. P. & W. BALDWIN,

Works:—WILDEN, near STOURPORT.

MANUFACTURERS OF

PURE CHARCOAL SHEET IRON, SUITABLE FOR ELECTRICAL PURPOSES.

London Agents: BROOKER, DORE & CO., Corbet Court, LONDON, E.C.

NOW READY, THE

"TELEGRAPH CONVENTION" CODES,

IN

ENGLISH, LATIN, FRENCH, GERMAN, DUTCH, ITALIAN, SPANISH & PORTUGUESE

SECTIONS.

THE MOST COMPLETE TELEGRAPH CODE IN THE MARKET

All Further Particulars on Application to

"THE ELECTRICIAN" PRINTING AND PUBLISHING COMPANY, LIMITED,

1, SALISBURY COURT, FLEET STREET, LONDON, E.C.

ADDRESSES.

LAING, WHARTON, & DOWN, 82a, NEW BOND-STREET, LONDON, W., Electric Light Engineers & Contractors. Sole Operators for England of the Thomson-Houston system of Arc Lighting. Special Agents for the Edison-Swan Co.'s Incandescent Lamps and Apparatus. Manufacturers and Suppliers of every requisite for Arc or Incandescent Lighting, Dynamos, Lamps, Switches, Electroliers, Brackets, &c. Specialities in Primary Batteries for Electric Lighting. Venetian Shades and Glass, Carbons, &c. Temporary lighting on any scale at short notice. Estimates free. Telephone No. 3602.

JULIUS SAX, Electrical Engineer and Electric Light CONTRACTOR, RIDGMOUNT STREET, STORE STREET, LONDON, W.C.

Established 1855.

Specialities—Electric Bells, Burglar Alarms, Fire Alarms, Watchmen's Clocks and Fire Indicators combined, Water Gauges, Billiard Markers, Electric Vanes, Lightning Conductors, Speaking Tubes, Gas Lighters, Electrical Testing and Telegraph Instruments, Electrical Torpedo Apparatus.

Automatic Call Bells for Fire Stations, &c., fixed at all Stations under the control of the Metropolitan Board of Works.

Call Calls for Police Stations, Prisons, &c., as devised for and adopted by H.M. Home Office. Contractor to H.M. Post Office and War Office.

Electric Lighting—Domestic and Public. Estimates Free on Application. Eight Prize Medals awarded.

Telephone No. 3848. Telegraphic Address: "*Sax—London.*"

WALTER T. GLOVER & CO., Electric Wire and Cable Makers, SALFORD, MANCHESTER. Works: Bridgewater-street, Broughton-road, Salford; Salford Electric Wire Works, Salford; Springfield-lane Cable Works, Salford. Established 1868. London Address, 10, Hatton-garden, E.C.; Telegram, "Phonoscope," London; Telephone No. 6691. Manchester—Telegram, "Walter Glover," Salford; Telephone No. 1187.

Specialities—Glover's patent covered Gutta Percha Wire for Leading-in, Tunnel, and Underground Work. Specially covered Iron and Copper Wire for Aerial Lines. Fancy covered single and Double Copper Wire (Paraffined) for Telephonic and Bell purposes. All classes of Silk and Cotton covered Wires for Instruments and Dynamo Machines, Glover's Patent Electric Light Leads and Cables for the various systems.

All descriptions of Covered Wire and Cables for Telegraphic, Telephonic, and Electrical Work, as supplied to the Post Office and the principal Railways, Electric Light, and Telephone Companies.

ADDRESSES.

LAURENCE, PARIS and SCOTT, Limited, Electrical ENGINEERS and CONTRACTORS, GOTHIC WORKS, KING-STREET, NORWICH. Dynamos, Motors, Automatic Cut-Outs, Back Current Cut-Outs, Excess Alarms, Multiple Switches, and Switch Boards. Complete Electric Lighting Plants. Central Station Plants. Estimates on Application.

PHILLIPS BROS., Electrical Wire Manufacturers, The Lea Telegraph Works, HACKNEY WICK, LONDON, E., late of Macintosh-lane, Homerton. Established 1870. Telephone No. 5422.

Specialities—Gutta Percha, India Rubber, Compound, Cotton, Silk, Flexible Cords, Telephone Wire, &c., &c. Multiple and other Wires. Special Wires for Dynamo Machines. Electric Light Leads, &c. Patent Non-Inflammable Insulation for Incandescent and Arc Lighting and Dynamo Machines.

THE LONDON ELECTRIC WIRE COMPANY, ANCHOR WORKS, PLAYHOUSE-YARD, GOLDEN-LANE, LONDON, E.C. (Late of Wenlock-buildings, Ironmonger-row, E.C.)

Specialities—Covered Wires of all descriptions for Electrical Instruments, Dynamo Machines, Bell and House Work, &c. Fancy Paraffined Wires specially prepared for Telephone and other indoor connections.

JOSEPH BOURNE and SON. Works: DENBY POTTERY, near DERBY. London: 6, ST. PANCRAS STATION. Manufacturers of the well-known Stoneware Telegraphic Insulators and Battery Jars. Brown Stoneware. White Stoneware. Brown Porcelain. Porous Cells. Economy, strength, durability, and perfect insulation combined. Prize Medal, Paris Electrical Exhibition.

Makers of Mr. Slater Lewis's Patent Self-Binding Insulator.

J. G. STATTER and CO., Limited, Engineers, ALLIANCE ENGINEERING WORKS, WEST DRAYTON. London Offices, Prince's Mansion, 68, Victoria-street, Westminster S.W. Dynamos and Motors for all Purposes. Perfect Constant-Current System of Arc Lighting. Estimates free. Write for Lists.

PATERSON and COOPER, Electric Light and Power and Telephone Engineers. EUROPEAN WORKS, POWNALL ROAD, DALSTON (Near Haggerston Station). Contractors to H.M. Government, Leeds Corporation, &c.

Specialities—Phœnix Dynamos, Pilsen, Phœnix, and Clark-Bowman and J. F. Arc Lamps, Cardew's Voltmeter, Paterson's Electromagnet Am- and Voltmeter, Ayrton-Perry Am- and Voltmeters, Wallace Diamond Carbons, Switches, Safety Junctions, and Fittings for Arc and Incandescent Lighting. (Removed from 76, Little Britain, since Nov. 16, 1885.)

Digitized by Google

THE
INDIA RUBBER, GUTTA PERCHA, & TELEGRAPH WORKS
COMPANY, LIMITED.

Offices: 106, CANNON STREET, LONDON, E.C.

MANUFACTURERS OF
DYNAMO MACHINES,
INSULATED ELECTRIC LIGHT WIRES AND CABLES,
Lamp Fittings, Switches and Testing Apparatus, Volt and Ampere Meters.

CONTRACTORS FOR THE SUPPLY AND FITTING UP OF
ELECTRIC LIGHT APPARATUS
OF EVERY DESCRIPTION.

INSTALLATIONS FOR CENTRAL STATIONS, SHIPS, HOUSES, OR FACTORIES.

ESTIMATES ON APPLICATION.

Works: SILVERTOWN, LONDON, E

[See detailed advertisement facing "Notes."

BAR-LOCK TYPEWRITER
W. J. RICHARDSON & Co. 12 & 14 QUEEN VICTORIA St. LONDON. E.C.

THE ONLY MACHINE
ON WHICH
THE WRITING IS VISIBLE,
AND EVERY LETTER
Printed on a Straight Line.

Will Manifold SIX Good Copies of a Specification at One Time.

SPECIMENS OF WRITING AND FULL PARTICULARS POST FREE.

TYPEWRITER COPYING DEPARTMENT.—ENGINEERING SPECIFICATIONS correctly COPIED with Despatch; One to Six Copies written Simultaneously; every Letter and Figure Printed on a Straight Line and Correctly Spaced. Price per Folio, 1½d. to 2d. Send a Trial Order to Test the LEGIBILITY and NEATNESS of the Writing.

W. J. RICHARDSON & CO.
12 & 14, QUEEN VICTORIA STREET, LONDON, E.C.

F. W. BERK & Co.
MANUFACTURERS OF
SULPHURIC ACID. NITRIC ACID. MURIATIC ACID.
ALL STRENGTHS PREPARED ACCORDING TO REQUIREMENTS.
WORKS: ABBEY MILLS CHEMICAL WORKS, STRATFORD, E.
PENTREPOTH CHEMICAL WORKS, MORRISTON, NEAR SWANSEA.
OFFICES: 1, FENCHURCH AVENUE, LONDON, E.C.

THE
ACME ELECTRIC WORKS
(ARTHUR C. COCKBURN, M.I.E.E., Manager),
FERDINAND STREET, CHALK FARM ROAD, N.W.

MAKERS OF
AYRTON and PERRY'S
PATENT MAGNIFYING SPRING
LONG-RANGE AMMETERS & VOLTMETERS

No Permanent Magnet Used. No Table of Values nor Multiplier Required, but each Instrument is Direct Reading throughout the Entire Range of the Scale.

The Divisions are Practically Equidistant all round the Scale; but, by employing a New Method of Constructing these Instruments, the Scale is now Graduated Correctly at **ALL PARTS**, and not merely at three points, as in the Older Type of these Magnifying Spring Instruments.

Every Instrument is tested by the Inventors, & bears their Certificate of Accuracy.

SOLE MAKERS OF
COCKBURN'S PATENT SWITCHES & CUT-OUTS.

Prices on Application for Above and Every Other Requisite for Electric Light Work.

TRADE "SANITAS" MARK.
DISINFECTANTS
(FLUIDS, POWDER, SOAPS),
NON-POISONOUS, PLEASANT AND BEST.
Used by more than 1,000 Boards of Health and Hospitals.
Gold Medals, Calcutta 1883-84, Paris 1885, Antwerp 1886.
For use at the Home and Foreign Stations of Telegraph Companies and on Board Ship
"Valuable Antiseptic and Disinfectant."—*Times*
"Safe, pleasant, and useful."—*Lancet.*
The "Sanitas" Company Limited,
LETCHFORD'S BUILDINGS, BETHNAL GREEN, LONDON.

Digitized by Google

coils by winding a hempen string between the contiguous turns, and a sheet of paper between adjacent layers. Indeed, this primitive device has reappeared of late in the winding of the secondary wire on cheap spark-coils. When ocean telegraphy loomed forward as the practical problem of the telegraph engineer, new modes of insulation had to be devised. It is hardly too much to say that the spread of ocean telegraphy would have been delayed at least half a century had not an insulating material turned up which presented the proper mechanical and electrical qualities—which should not only be a splendid non-conductor, but which should also be water-proof, flexible, and mechanically capable of resisting enormous hydrostatic pressures. The material gutta-percha seems to have been designed by Providence for this especial purpose. Though many artificial substitutes have since been devised, the telegraph engineer would be decidedly put into an awkward fix should the supply of gutta-percha be (as seems not unlikely to be the case) seriously diminished. Indiarubber compounds, ozokerit, Trinidad bitumen, tarred hemp, and other materials there are in plenty; but none of them can so fully replace gutta-percha as to make this marvellous substance superfluous. There is yet room for further development in the art of manufacturing materials of this nature.

If we turn from the protection of wires and cables to the insulation of the working parts of dynamo machines and motors, we find that with the different conditions, mechanical and electrical, other materials are needed and other modes of applying them must be devised. Laminæ of mica are almost universally employed for insulating between the bars of commutators and below the binding wires of rotating armatures. Its great power to resist transverse forces, and its excellent anhygroscopic properties, alike recommend it for this purpose. In many cases the thin flimsy sheet, excellent as it is from the purely electric point of view, needs to be backed up mechanically by layers of varnished paper or other materials, which, though electrically weaker, are mechanically stronger. The best insulation in the long run is not by any means that which, when it leaves the testing-room, exhibits the greatest number of megohms of resistance: it is rather that which, whatever its nominal goodness, does not break down under the severer test of everyday work. Varnished canvas, Willesden paper, vulcanised fibre (so-called), and asbestos cardboard have all been used, and some of these are excellent in their proper place. It is said that sulphur is employed to insulate the armatures of certain American motors for tramcars. If we are not mistaken, the armature coils of Mr. Ferranti's new dynamos are held in place by a mixture of powdered glass and sulphur, which is run in while hot and firmly fills up the space between the coils and the frames in which they are clamped. Dynamos which are to work at high potential need to be insulated with special care. We know of one eminent maker who insulates the laminated iron cores of his armatures with several alternate layers of mica and varnished paper. Another lacquers his finished armature cores, before winding, with bath enamel, and heats them in the stove to harden it. Another uses the much-belauded Aspinall enamel. Another covers his cores with linen tape, which is then soaked with Scott's rubber varnish.

From dynamos one naturally passes to lamps. The insulation of arc lamps is an art in itself. It is not a very simple problem how to pass the current into and out of the carbon-holders when both are permitted to move, and when one or both of them must be perfectly insulated from the main frame of the lamp. No two makers carry out the insulation in the same way. A similar remark applies to the fittings for glow-lamps. At one time plaster of Paris—a substance objectionable because of its porosity—was largely used to bed the conducting terminals in the socket. For a time this substance gave way in favour of vitrite—a species of slag glass—which, however, declined in favour, as it was found to be very liable to fracture under unequal heating.

For the efficient insulation of main circuits in underground conduits, many devices have appeared. Mr. Brooks' plan of supporting the bare copper conductors mechanically by insulating washers at intervals inside a metal pipe, which then is filled with some cheap oil, is an excellent one where there are no gradients. A recent variation in this mode consists in winding a hempen rope in very wide spirals around the copper conductor in lieu of washers. The use of bitumen as a substance for insulating cable mains has been enthusiastically advocated by Major-General Webber. Another careful constructor—or rather, firm—runs bare copper strips in covered iron boxes of water-tight design, the copper strips reposing in nicks in stoneware pieces placed at intervals along the conduit. Mr. Ferranti, after trying many things, has adopted an insulation made of brown paper and shellac mechanically gripped between the inner and outer tubes of copper that he proposes to use as conductors. Using a Wimshurst machine and a battery of Leyden jars, he has failed to break down samples of this structure, though the potential must have been some hundreds of thousands of volts. This is not an unimportant matter.

It may be quite right, as some engineers have suggested, to test at regular periods the insulation-resistance of a circuit, or of a network of mains, by the use of a mirror galvanometer and a couple of Leclanché cells. But such tests, however many millions of ohms they show as the nominal insulation resistance, are utterly useless from the point of view of detecting probability of breakdown. What is wanted is a test executed with an electric potential exceeding that which will be habitually employed. No competent engineer would regard as a satisfactory test of the strength of a bridge an experiment made by observing a microscopic deflection of the girders under a force of a few pounds. The ordinary tests of insulation resistance made with galvanometer or Wheatstone's bridge are equally uninforming on the crucial point. For an insulation that is to be used at high potentials a high potential test is absolutely essential. The tendency to break down the insulation depends upon the electric tension or stress in the insulating medium; and the tension on the insulating medium is proportional (*ceteris paribus*) to the square of the potentials applied. A potential of a thousand volts applied to a given insulator produces in the substance of that insulator an electric tension a million times as great as that which would be produced by a potential of one volt. This distinction between the tension in the dielectric and the potential that causes it, is one often entirely overlooked by the careless thinker, who is too apt to use the words tension and potential as though they meant the same thing. But from the point of view of the liability of the insulator to be pierced by a spark, it is most important to observe the distinction. Doubling the potential will make the actual tension in the insulating medium four times as great, and quadruples the liability to break down. It is told—and the story, if it is not true, ought to be—that when Mr. Edison visited the Deptford station he was observed to be in a meditative mood, and when asked what he was thinking of, replied that he was pondering over that eighth of an inch of ebonite which was interposed between the ten thousand volts and human life. It may be perfectly true, as Sir William Thomson once observed, that ten thousand volts is no more dangerous in the laboratory than a circular saw is. But one would hardly like to risk a circular saw amidst an unsuspecting community with only an eighth of an inch of ebonite between them and instant death. The safety of the community—so recklessly defied in the ramshackle arrange

Digitized by Google

ments of overhead wires on high-potential circuits in the cities of the United States—cannot be disregarded here in England. The community demands protection from danger: to secure efficient protection is the aim and end of the art of insulation.

REVIEWS.

Electricity in Modern Life. By G. W. De Tunzelmann, B.Sc. The Contemporary Science Series. (Walter Scott and Co.)

This book aims at giving a short, clear, and connected sketch of the chief useful applications of electricity, their historical development, and the scientific principles underlying them. The author has, on the whole, succeeded admirably; and his book appears opportunely at a time when a rapid advance in electrical industry is recalling public attention to a favourite subject, and thereby creating a demand for books of this kind, addressed mainly to non-technical readers.

The reader is first of all treated to eight chapters of scientific principles. The fundamental facts of electricity and magnetism and the chief terms in use are explained. A chapter on force, work, and power, and another on the chief sources of electricity, lead up to the consideration of magnetic fields and lines of force. An excellent chapter on electrical measurement follows. In this the history of the growth of the electrical system of units is given, and the important influence on its development of both theoretical and practical men is clearly shown. The chapter on electrical machines is spoilt by the startling statements that it is impossible to use a series dynamo either for charging accumulators or for electroplating purposes, and that the three kinds of self-exciting dynamo are the series, the shunt, and the "separate circuit self-exciting" machines. The compound-wound dynamo is not mentioned. The names of Varley and Wheatstone are omitted in connection with the discovery of the self-exciting principle, although that of Siemens is given.

The opening portion of the book is necessarily rather briefly sketched owing to the amount of ground which has to be covered in order to introduce the remaining chapters (twelve in number), which are devoted to popular but correct descriptions of the numerous uses of electricity in modern life. A considerable space is devoted to the romantic story of the overland and submarine telegraph. The historical summary is very complete, and is written in a fluent and interesting style. The evolution of the telephone is fully gone into, and the working of an exchange is described. Among the comparative novelties introduced are Robertson's writing telegraph, the photophone, the water-jet transmitter of Chichester Bell, the Tainter-Bell graphophone, and the new Edison phonograph. The author usefully compares the improvement in the phonograph introduced by Bell and Tainter, who substituted a continuous curve for the separate indentations of Edison's original instrument, with that effected by Graham Bell in Reis's telephone by the substitution of an undulatory current for a series of intermittent ones. The author's apology for introducing the phonograph into his book is rather unnecessary, as the general public have always regarded the words electrical and marvellous as synonymous, and in this sense, at all events, the phonograph may be described as an electrical instrument. In the chapter on electric lighting, the work of Swan, in connection with the filament of the incandescent lamp, is made subordinate to that of Edison, and the work of Lane-Fox is not mentioned. The author lays proper stress on the important influence of the invention of the dynamo on the development of the glow lamp, but hardly states the almost equal importance of the improvements in the mercury pump. The remaining chapters of the book deal with various applications of electricity to traction, metallurgy, warfare, and medicine. A useful index is appended. The book is very well printed, and the illustrations are numerous and well executed. We can confidently recommend the book, not only to the class of readers for whom it is chiefly intended, but also to the average student of electricity, who will therein find much to interest and instruct him.

ON THE HEATING OF CONDUCTORS BY ELECTRIC CURRENTS.*

BY A. E. KENNELLY.

(Concluded from page 172.)

The Heating of Conductors Suspended in the Open Air Overhead.

For these measurements nine wires were suspended about 6ft. (180 centimetres) from the ground parallel, to each other, one foot (30 centimetres) apart and supported on glass insulators. The current was led through these wires in series, and the potential difference between points on each wire a measured distance apart observed in the usual way. The tests were made on two successive days, four wires being tried at once on the first day and six on the second, one wire having the benefit of a second trial. They were in the shade, and the temperature of the air was 28°C. by dry and 26°C. by wet bulb thermometer. The weather was calm, but there were at times, particularly on the second day, slight gusts and motions of the air—not amounting, however, to a steady breeze. The effect of these disturbances on the temperature of the wires was so great that the readings were all very unsteady and difficult to observe. On several occasions the effect of increasing the current in the wires was not only neutralised, but even apparently reversed, by an increased motion of the air. Consequently the results obtained have been much less reliable than those deduced from similar wires indoors. There can be little doubt that if the air out of doors were as tranquil as that in a closed room, the cooling of wires would differ in those places only in respect to radiation. This is of course seldom, if ever, the case, and the effect of the air's motion in assisting convection is very great. These results may fairly serve to indicate the maximum temperature elevation overhead wires can attain in calm weather, but to what extent the convective loss of heat can attain in windy weather is not known, and is probably many times greater than that here determined.

Fig. 5 shows the curves plotted from the observations. Owing to the variation in the readings some little judgment had to be exercised in selecting the best mean value. Two of the wires were covered with white cotton, one covered with braided and blackened cotton, while the remaining six were bare, soft copper wires, such as are generally used for overhead electric light conductors. The black-covered wire is shown to have maintained about 25 per cent. less temperature elevation than the bare wire of equal diameter and conductivity. On the other hand, the white-covered wires Nos. I. and VII. in the figure were sensibly hotter than the corresponding diameters of bare wire, the elevation of No. VII. being about 10 per cent., that of No. 1 nearly 50 per cent. in excess. This large excess in the latter case is, however, perhaps attributable to the fact, discovered in working out the results, that the conductivity of this wire was low and its behaviour may not have been reliable. The fact of the cooling of a wire being assisted by an insulating covering was pointed out on theoretical grounds by Prof. Forbes in his Paper already alluded to. He showed that the greater radiating surface so obtained more than compensated, up to a certain thickness of coating, for the poor thermal conductivity of the insulator. It appears, however, that with these wires tested the white covering formed an exception to the rule, the surface being probably less favourable to radiation. Curves Nos. IV. and V. represent the behaviour of the same wire on the two successive days, and show the temperature elevation to have been about 7 per cent. less on the second trial, owing perhaps to the greater degree of movement in the air on that occasion, as already mentioned.

Fig. 6 gives the estimated best mean values of the convection for each of the bare wires at various temperature elevations. These have been obtained by deducting from the total energy per linear centimetre the radiated loss as determined from the measurements indoors, and the difference is shown as convection in watts per linear centimetre. Owing to the great variation noticed in the convection, they cannot be regarded as more than approximations, but as far as 40°C. of rise they appear to be nearly straight lines, with the exception of the smallest wire. The excess of convection over that found within doors is also practically proportional to the diameter of the wire. Nor is it unreasonable that while with the convection in still air, where the energy of displacement is entirely supplied by the wire through conduction, the diameter of the wire may not play a prominent part; yet when the energy of the moving air is supplied from external sources, and the air passing round the wire carries off its heat, the increase of convection should depend upon the extent of the hot surface exposed, and hence be closely proportional to the diameter.

* Abstract of Report read before the Edison Convention at Niagara Falls, August, 1889.

Digitized by Google

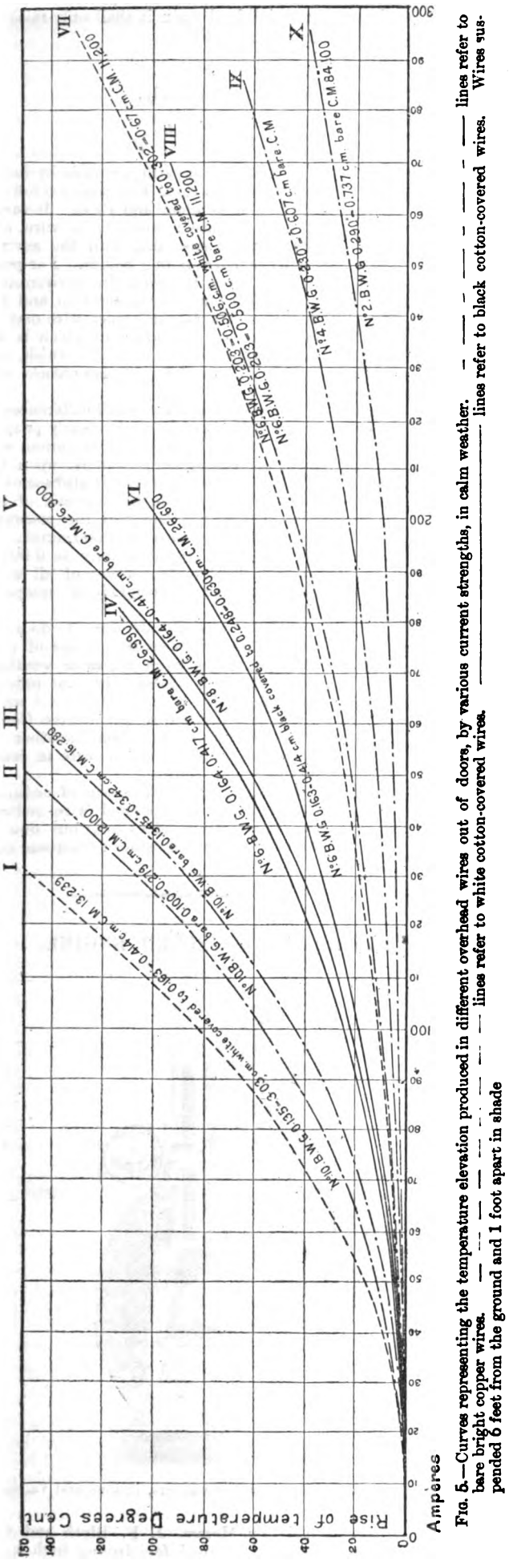

Rise of temperature Degrees Cent.
Amperes
I
II
III
IV
V
VI
VII
VIII
IX
X
N°2 B.W.G. 0·280 = 0·737 c.m. bare C.M. 84·100
N°4 B.W.G. 0·230 = 0·607 c.m. bare C.M.
N°6 B.W.G. 0·203 = 0·535 c.m. bare C.M.
N°8 B.W.G. 0·165 = 0·435 c.m. bare C.M. 26·900
N°8 B.W.G. 0·165 = 0·417 c.m. bare C.M. 26·930
N°8 B.W.G. 0·165 = 0·417 c.m. bare C.M. 16·280
N°10 B.W.G. bare 0·135 = 0·343 c.m. C.M. 13·230
N°10 B.W.G. bare 0·135 = 0·343 c.m. C.M. 13·239
N°10 B.W.G. 0·135 = 0·343 c.m. white covered C.M. 13·239
N°10 B.W.G. bare 0·135 = 0·343 c.m. C.M. 13·100
N°10 B.W.G. 0·135 = 0·343 c.m. white covered C.M. 11·200
N°10 B.W.G. 0·135 = 0·343 c.m. bare C.M. 11·200
N°10 B.W.G. 0·135 = 0·343 c.m. bare C.M. 11·200
N°10 B.W.G. 0·135 = 0·343 c.m. bare C.M. 11·200

FIG. 5.—Curves representing the temperature elevation produced in different overhead wires out of doors, by various current strengths, in calm weather. — — — — lines refer to bare bright copper wires. — · — · — · — · — lines refer to white cotton-covered wires. — — — — lines refer to black cotton-covered wires. Wires suspended 6 feet from the ground and 1 foot apart in shade

The best mean values of the convection afforded by the experiments appear to be :

·00175 + ·013 d watts per linear centimetre per degree Centigrade elevation ;

d being expressed in centimetres, so that the convection from an overhead wire 1 centimetre in diameter would be eight times as great as within doors. Modifying the previous formula to these data, it becomes :

$$c = \cdot 886\, d \sqrt{\frac{d\,(m\ \pi\ R_t + \cdot 013\ t) + \cdot 00175\ t}{r\,(1 + \cdot 00388\ T)}}.$$

Simplifying, for bright copper, $m = 1$,

and $$c = 28 \cdot 9\, d \sqrt{\frac{570\ Q\ R_t + 7 \cdot 4\ d\ t + t}{1 + \cdot 00388\ T}}\ ;$$

and for blackened copper,

$$c = 28 \cdot 9 d. \sqrt{\frac{1140\ Q\ R_t + 7 \cdot 4\ d\ t + t}{1 + \cdot 00388\ T}}.$$

These formulæ involve the assumption, known to be inaccurate, that the radiation has the same value out of doors as within, the error involved not being large, and they can at best only fix the maximum elevation of temperature attainable in calm weather. By their use the following table has been calculated up to 1,500 amperes, although 300 amperes was the strongest testing current. To the latter limit, however, the accuracy of the table in representing the heating as actually estimated from the measurements may be judged from the following comparison between observed and calculated currents in the case of the four largest wires:—

Diameter inches.	5°C.		10°C.		20°C.		40°C.	
	Observed.	Calculated.	Observed.	Calculated.	Observed.	Calculated.	Observed.	Calculated.
·164.....	54	54	72	75	95	105	127	142
·203.....	72·5	72	102·5	101	145	142	195	196
·239.....	93	92	140	129	192	180	250	250
·290.....	155·5	123	202	170	254·5	240	305	328

Table of current strengths (minima) which will elevate the temperature of bare overhead copper wires of 98 per cent. conductivity, 5°, 10°, 20°, and 40°C. in calm weather, for any given diameter up to one inch.

Diameter		5°C.		10°C.		20°C.		40°C.	
Inc.	Cm.	Bright.	Blaknd.	Bright.	Blaknd.	Bright.	Blaknd.	Bright.	Blaknd
·05	...	12	13	17	18	23	25	30	33
·10	...	28	30	40	42	55	57	75	78
·15	...	48	51	67	70	94	98	130	135
·20	...	71	74	99	105	139	148	193	201
·25	...	98	101	136	143	190	200	264	278
·30	...	128	131	178	186	250	260	344	360
·35	...	160	164	224	232	312	336	426	450
·40	...	193	201	271	234	376	390	518	546
·45	...	229	241	321	337	446	468	616	652
·50	...	268	282	374	393	521	548	719	761
·55	...	308	324	430	452	599	630	825	873
·60	...	349	367	488	514	679	714	932	990
·65	...	390	410	550	580	762	802	1,050	1,110
·70	...	434	456	612	626	850	893	1,170	1,240
·75	...	480	506	677	715	940	988	1,296	1,370
·80	...	530	556	745	786	1,030	1,080	1,440	1,510
·85	...	580	608	816	862	1,130	1,190	...	...
·90	...	632	662	890	934	1,230	1,300	...	...
·95	...	688	720	960	1,010	1,340	1,410	...	...
1·00	...	740	780	1,030	1,080	1,440	1,520	...	...
...	·2	21	23	29	31	40	44	55	59
...	·4	52	54	71	75	100	105	139	145
...	·6	90	93	125	132	175	184	244	256
...	·8	139	141	192	200	268	280	370	388
...	1·0	190	196	264	276	367	380	506	533
...	1·2	245	257	343	360	478	501	560	600
...	1·4	310	325	432	453	602	632	816	877
..	1·6	375	393	525	553	728	765	1,000	1,060
...	1·8	443	465	625	660	870	910	1,190	1,260
...	2·0	517	544	728	765	1,010	1,060	1,400	1,470
...	2·2	586	624	839	880	1,160	1,220	...	...
...	2·4	680	710	950	995	1,300	1,370	...	...

This table i represented graphically by Fig 7.

Digitized by Google

Resumé of Results.

Wires in wooden panelling heated by currents are cooled by conduction under complex numerical conditions. As the temperature of the wire and panel rise, radiation and convection come into play. No simple and precise law can be given for the limiting temperature, but the limiting safe current approximately follows the diameter in sesquiplicate ratio; or in symbols, the best empirical formula is

$$c = ad$$

Also if the limiting safe diameter of an insulated panelled wire be such that twice the proposed full load upon it shall only raise its temperature 40°C., then the best formula is

$$d = .0147\, c^{\frac{2}{3}},$$

d being in inches and c in amperes; or roughly,

$$d = \frac{c^{\frac{2}{3}}}{70}.$$

A bare wire in still air cools by radiation and convection. The radiation follows the law of Doulong and Petit. It varies with the surface nature of the wire, and also, strictly speaking, with the surface nature of surrounding bodies. For practical purposes, however, the environment may be left out of consideration and the radiation of a bright copper wire may be multiplied by a coefficient which is 1·7 for a surface of thin shellac varnish, and 2·0 for a varnish of lampblack and shellac.

The convection for small differences of temperature appears to be nearly proportional to the temperature elevation, and depends, among other things, upon the form of the conductor. It also seems to increase slowly with the diameter of the wire, but more than this the measurements have not thus far determined. It may be taken approximately as 0·00175 watts per linear centimetre of all wires for each degree Centigrade of temperature elevation.

A bare wire in air out of doors is subject to a very great increase of convective cooling even in calm weather. The convection excess over that indoors may be roughly taken as $0{\cdot}013 \times d$ watts per linear centimetre per degree Centigrade elevation in calm weather, d being the diameter of the wire in centimetres.

A coating of black cotton of ordinary thickness on a suspended wire reduces the temperature elevation, but one of white cotton seems rather to increase it.

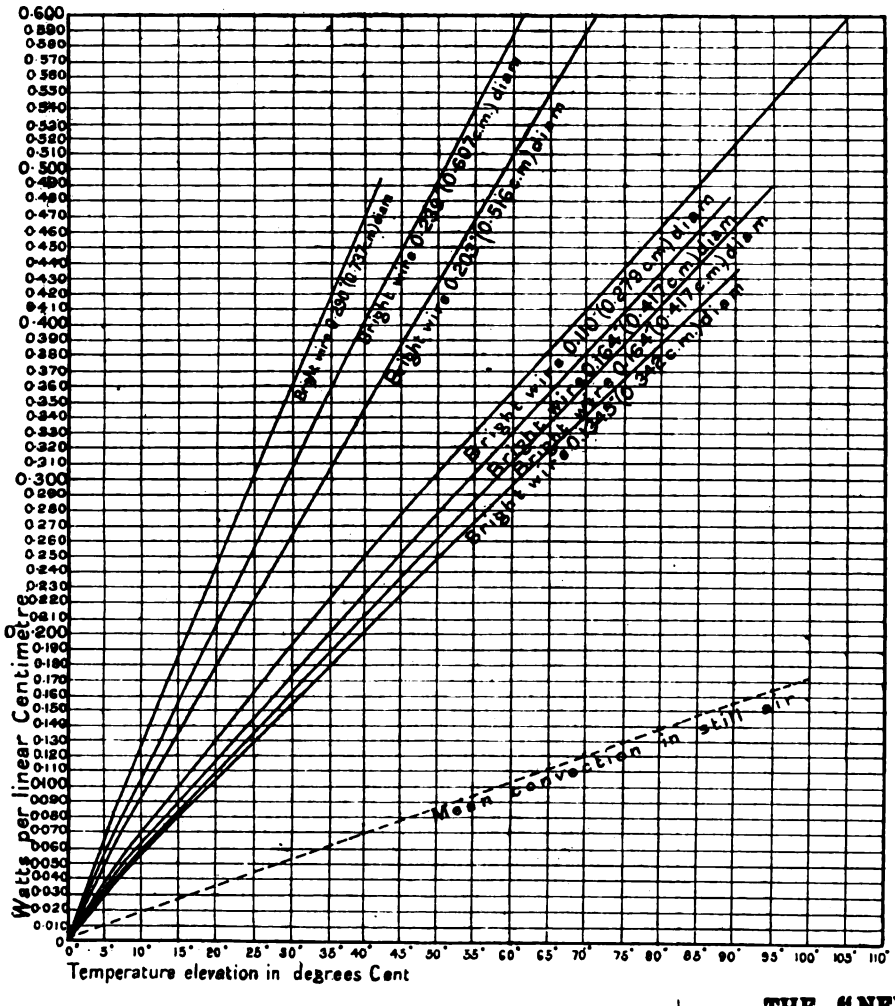


Fig. 6.—Curves representing the estimated mean values of the convection at different temperature elevations of six bare copper wires suspended on poles out of doors in calm weather.

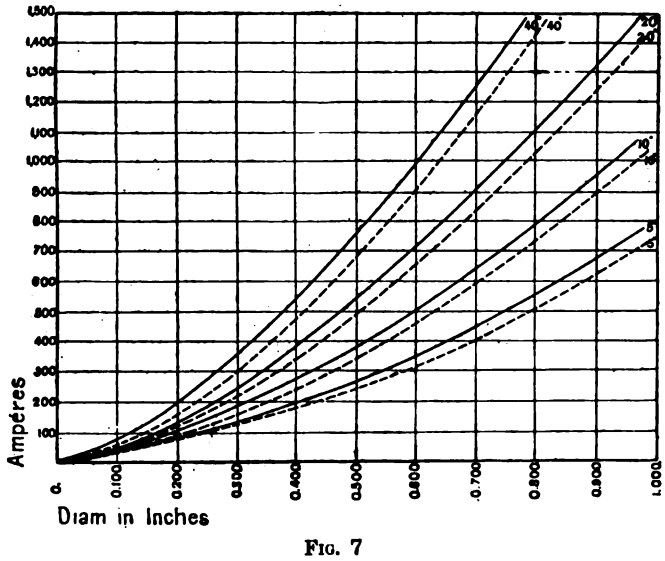


Fig. 7

THE "NEWALL" HIGH-SPEED ENGINE.

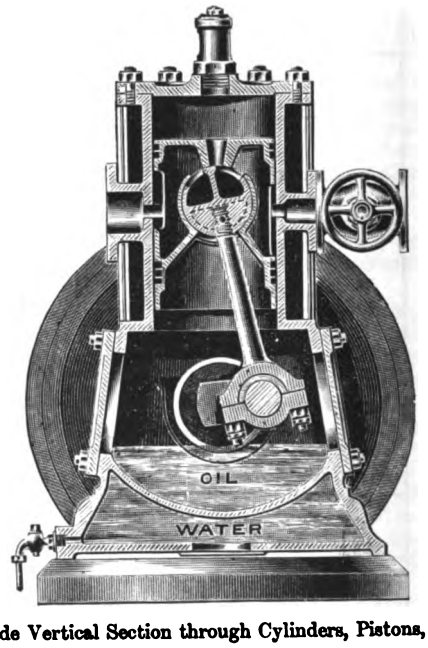


Fig. 2.—Side Vertical Section through Cylinders, Pistons, and Valves.

This engine, which is made by Messrs. J. F. Blyth and Co., of Millwall, has been especially designed for driving high-speed machinery; and, owing to the absence of eccentrics, rods, and the

Digitized by Google

usual valve gear, it is one of the simplest of engines. In a single cylinder, or one-tandem engine, there are only three moving parts, and in a two-tandem engine only five working parts in all. This engine has been in existence nearly two years, and during this time it has undergone many and various improvements. The "Newall" engine can be readily constructed on the simple high-pressure compound or quadruple expansion system. The chief aim has been to build a useful and economical engine taking up very small space, and to reduce the number of moving parts to a minimum. The "Newall" engine, it is claimed, is particularly adapted for running at very high speeds, is noiseless in action, and completely dust-proof, while the absence of long ports and passages makes it adapted to act as an air-pump or exhauster, inlet and outlet valves being entirely dispensed with. In compound and quadruple expansion engines the cylindrical oscillating valve is divided into four pockets or recesses for controlling the steam between the smaller and larger cylinders. During recent trials at the maker's works, both the high-pressure and compound engines are said to have given every satisfaction, the revolutions at which the machines were designed to constantly run at have in all cases been more than doubled, showing little or no friction, and the testimonials received prove that the "Newall" engine has met with considerable favour.

Fig. 1 is an external view of a double cylinder high-pressure engine, fitted with water relief valves, fly-wheel, and driving pulley

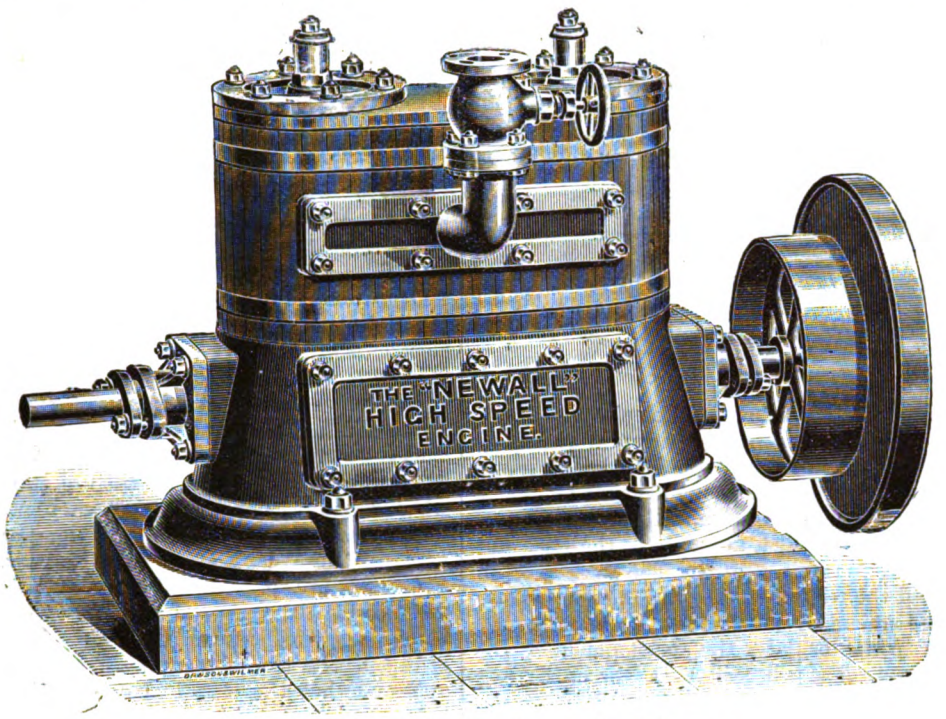


Fig. 1.—Double-Cylinder High-Pressure Newall Engine.

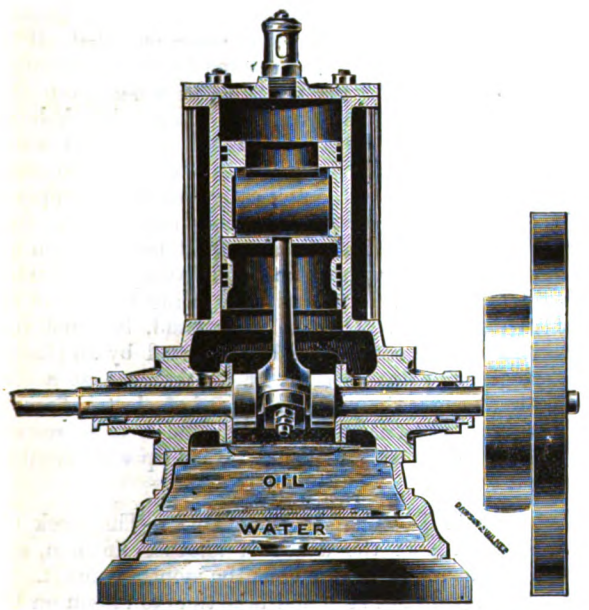


Fig. 3.—Front Vertical Section through Cylinders, Pistons, and Valves.

most economical in steam. Like most engines of its class, the pistons are single-acting in all cases; the connecting rods, brasses, and bearings are always kept in compression. The steam-controlling medium consists of a cylindrical oscillating valve attached to one end of the connecting rod, and formed with suitable ports and recesses, which open and distribute at the proper moment the steam to the various cylinders of the engine. The steam can be cut off at any portion of the stroke, while at the same time any required amount of cushion may be adjusted. The machine may be further for ordinary purposes. Figs. 2, 3, and 4 represent the side and front vertical sections and plan through the cylinders, pistons, and valves of the "Newall" engine. The chamber below contains the oil, separated by a partition formed with syphon holes for draining off any water due to condensation on passing the piston. The bearings are unusually long, and are grooved to retain the oil: a suitable recess, or pocket, formed in the top of the bearing, catching the oil and lubricant when agitated within the crank-chamber by

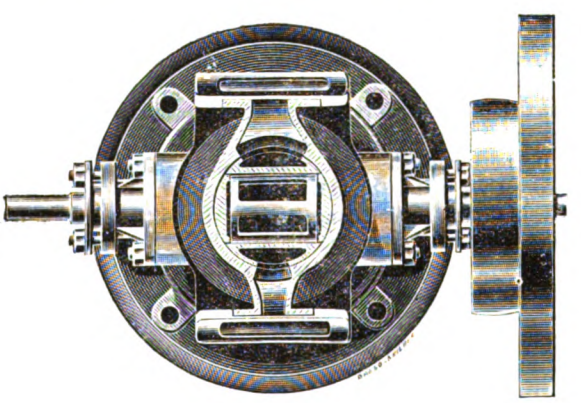


Fig. 4.—Plan.

the crank and connecting rod brasses; the lower half of the brasses are opened at the fillets, so that at every revolution the crank pins and bearings are saturated by the oil. The pistons are perfectly balanced, and working surfaces have large areas, and the makers assert that after two years' wear of the valves and pistons in a two-cylinder engine for driving the works, the tool marks were not worn out of the valve, which proves the friction to be slight. Several "Newall" engines are now driving dynamos, and would seem, owing to their simplicity, to be especially suitable for such work.

Digitized by Google

THE EDINBURGH EXHIBITION, 1890.

The following circular letter has been sent by the Secretary of the London Chamber of Commerce to the members of the Electrical Trades Section :—

DEAR SIR,—Referring to my circular letter of the 28th ultimo, relative to the terms which the Committee of the Electrical Trades Section of this Chamber have negotiated with the Edinburgh Exhibition authorities, I beg to advise you that the replies so far received from members of the Section are favourable to the acceptance of Mr. Lee Bapty's proposals. It is therefore suggested that members who intend to exhibit should send in their entry forms direct to the Exhibition authorities, with the proviso that they do so on the terms of Mr. Lee Bapty's letter to the Electrical Section. The question of appointing technical attendants at the Exhibition on behalf of the Section, the choice of judges, and tests, will be dealt with by the Committee of the Section in due course, but intending exhibitors must be reminded that applications for space should be made by the 31st instant.—I am, dear sir, yours faithfully, KENRIC B. MURRAY, Secretary.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *December* 14, 1889.

The Western Union Company and the Telephone.—If one were to believe some of the statements appearing in the daily papers here, Mr. Jay Gould is not in a particularly happy frame of mind over his telegraphic interests. Long-distance telephone lines continue to extend in every direction, and during the past year the system has been perfected, not only in the East but through the Middle and Western States. The work is of an excellent character, and the results in the transmission of conversation and news are eminently satisfactory. It seems inevitable, therefore, that sooner or later the development of the long-distance telephone service will lead to a direct contest and conflict between the telephone and telegraph interests. The stories, however, told by the newspapers as to the injury done to the telegraph business by the telephone, smack of exaggeration. It is always hard to determine the exact amount of effect in the case of competition of this kind, and, so far, the telegraph returns have more than held their own. At the present minute, for example, the Western Executive Committee have recommended that the regular 1¼ per cent. dividend shall be declared, and that there shall be an extra dividend of ¾ per cent. This means 5¾ per cent. for the year, and would indicate that next year the rate will be 6 per cent., or even better. The actual figures for the quarter indicate phenomenal earnings. The net earnings for the September quarter are said to reach just over $2,000,000, while the estimate was only $1,750,000. This would beat the record, it is said, and practically place the Western Union Stock on a 7 per cent. basis again. I hinted at this possibility a month or two back, and the returns have been growing better all the time. It might reasonably be inferred, therefore, that just now the Western Union Company is not feeling the strain of any severe competition; but it does not follow that when the service of the Long-distance Telephone Company is complete everywhere, that Company will not devote a great deal of its time and a good many of its wires to the development of business such as is now done by the Western Union Company. It might be supposed that the telephone people were very much masters of the situation. They may be in some respects, but they also have their own little troubles. Thus, for instance, until within a very short time they have been at liberty to string their wires everywhere. Now, however, the electric railway business is rapidly pushing to the front, and it is now generally understood, as well by the public as by the experts, that telephone wires running near the wires of an electric railway are practically useless. Various remedies have been proposed, and some have been adopted with more or less benefit; but there is no denying the fact that the trouble has been one of the most serious that the telephone companies have encountered of late years. Thus, in Boston, the 400 miles of overhead conductor for the electric railway service with their heavy currents make a material difference in the conditions under which all the overhead circuits carrying small currents have been operated, and the Telephone Company there does not relish the situation at all. The solution that offers itself in large cities is the placing of the telephone wires underground in special conduits, where they will be out of the way of the heavy-current wires, so that they can neither suffer induction from them nor fall across them and render a fire possible.

The Boston Fire.—Speaking of the condition of affairs in Boston reminds me of the recent serious fire there, which resulted in a damage of about a million pounds. I understand that immediately after the fire, reports were cabled to England fixing on the electric wires the blame for the outbreak of the conflagration, and that there was something approaching a scare on the subject among those interested in electric lighting enterprises. If that be so, it will interest your readers to know that the mayor of the city, in a communication to the Board of Aldermen, has stated his belief that no evidence has yet been adduced to establish the truth of such statements. Mr. S. E. Barton, Chairman of the Electric Lighting Committee of the New England Insurance Exchange, a well-known body whose opinion is authoritative in such matters, says, in a letter to the Boston *Herald*, that as the result of pretty thorough inquiry, he disbelieves the electric wire theory on the subject. The fact is, the more the inquiry is being prosecuted the less reason does there appear to fix on electricity the blame of the fire. When the first reports of the fire went out it was boldly stated that it was caused by the crossing of time wires with electric light wires. Then the fact came out that the fire started after the arc light wires were out of operation. Then it was stated that the fire was caused by the crossing of time wires with the trolley wires of the West-End Electric Railway. These electric railway wires are protected by guard wires and are at some distance from the scene of the fire. Then it was said that the blame was fixed on the time wires by the stopping of some of the electric clocks just about the time of the fire. It then appeared that the clocks in question had stopped the night before, owing to a disconnection of the circuit, while the stoppage of the other clocks was directly attributable to the fire itself. Then it was said that the fire might have been started several hours in advance by the time wires, because they were not protected, whereupon it came out that all the wires of the Time Company were protected by fusible cut-outs. The probability is that the fire was due to some overheated flue. The day of the fire, Thanksgiving, was a public holiday. During such a holiday the district that was consumed would practically be deserted. At the same time it would be necessary to keep the fires up with practically two days' supply of fuel. It does not require a very vivid imagination, under such circumstances, to see how easily a fire could have broken out through defective heating apparatus, and having once started, could have got a good headway without being noticed in the very heart of a building. On the other hand, it is not very easy to see how the fire could have been started by an electric wire without giving palpable signs of its presence at a very early moment. That is the peculiar nature of electric fires, as everybody knows. Electricity has quite enough to be responsible for in these days without being loaded up with troubles that it has not caused.

The Accidents to Linemen in New York.—This week the New York papers report the death of another lineman, and some of them, as usual, are foaming at the mouth about it. It is really a pity they do not stop and take time to reason on the facts which they themselves print. It appears that in the case in question the lineman was working on one of the circuits of a suburban company. During the winter months the company turn on the current of their circuits at four o'clock. Notice to this effect is posted at the station, and the linemen are naturally supposed to be aware of the fact and to stop work. Late that afternoon, after four o'clock, without taking any trouble whatever to ascertain whether the circuit had gone into operation or not, the lineman in question climbed the pole and for the purpose of making a new connection cut the circuit with a pair of uninsulated pliers which he held in his bare

Digitized by Google

hand! That he was killed almost immediately goes without saying, and, of course, he was pretty well roasted before being taken down. If the public expect such accidents as these to be prevented by highly-insulated line wires and carefully-protected lamps, or even by placing the wires underground, they are, of course, utterly mistaken. So long as there is gross, wanton carelessness of this kind, men must pay the penalty of their lives. They do it in other industries, and it cannot be expected that electricity will prove any exception.

CORRESPONDENCE.

"THE ELECTRIC LIGHT IN ENGLISH TOWNS."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I desire to point out several important misstatements in the report of the Electric Lighting Committee to the Dublin Town Council, which appears in your issue of the 20th inst., on pages 172 and 173. In the schedule of prices the phrases used are unintelligible as they stand. The first should read "for the first 100 hours supply of the maximum supply demanded at the rate of 1s. per Board of Trade unit," and so on for the two other clauses of the sliding scale.

What is meant by "the tube containing the wires"? Again, the statements made would lead one to suppose that the cables —or what is presumably intended to refer to them—"the tube containing the wires"—were in contact with the cast-iron troughing. This is not so. It is rather a pity that the report does not show plainly what has been done and what a very simple though extremely good arrangement the engineers of the Company, working in conjunction with a very well-known and much-respected firm of cable manufacturers, have brought into extensive practical use, the canalisation being constantly under pressure, and showing very high electrical constants—the word constant being here used in its true sense. "High tension with transformers." *Really*, then, they must be infinitesimal in size, and are concealed in the lampholders, or something of the "Diehl" pattern, and the "high tension" must be such as no ordinary voltmeter will detect, as any of the usually accepted instruments show 110 on their dial if connected with the mains; and—a point of considerable importance, after the experience some of us have had in the Metropolis—that will be the indication in wet weather or fine weather, barometer high or barometer low. This says a good deal for the Siemens dynamos and Willans engines, as well as for the attendants in charge of them. —Yours, &c.,

C. H. Y.

December 23, 1889.

PHOTOGRAPHING ST. ELMO'S FIRE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It is some years ago since I saw a paragraph in some of the scientific papers to the effect that a Berlin photographer had got an image of St. Elmo's fire on the top of the lance in the Amazon statue, but I cannot now trace the reference.

This has been a very puzzling thing to me for some time, especially bearing in mind the enormously greater length of the waves concerned in the propagation of electric (or electromagnetic) influences as compared with those of light. Dr. O. Lodge has been trying hard to get these waves shortened down to light waves, but here seemed to be a case in which, somehow, an electrical influence gave rise to waves which were shorter than those of light—being apparently ultra-violet, since the image on the top of the spear did not correspond to anything visible to the naked eye.

Do not, however, Mr. Shelford Bidwell's recent experiments on the effect of electrification on a steam-jet seem to throw some light on the phenomenon? And may not the brush discharge sometimes render aqueous vapour in the air opaque to the actinic rays, and not to the longer ones of the visible part of the spectrum?—Yours, &c.,

T. ARNALL.

City of Birmingham Surveyors' Department,
The Council House, Dec. 23, 1889.

THE HOOKHAM METER ACTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: We have had our attention drawn to a paragraph in your issue of December 13th, headed "Curious Treatment of an Electric Meter." We presume your report is taken from the *Birmingham Daily Post*, as it is about as inaccurate and unfair as that paper's report. We enclose a copy of our letter to the Editor of the *Post*, which puts rather a different complexion on the case. We think you will agree with us that this paragraph should be headed "Curious Specimen of Birmingham Reporting." We should be glad to show your representative over the installation in which the meter was placed, as it would appear that the work had been very badly done from your report. Such, however, is not the case, as Chamberlain and Hookham's own engineer said it was one of the most complete he had ever seen. We trust you will give this statement of facts as prominent a place in your next issue as was given to your report in issue of December 13th.—Yours, &c.,

MONTAGU J. SCOTT AND CO.

100, Jermyn-street, St. James's.

Copy of Letter to Editor of "BIRMINGHAM DAILY POST."

CHAMBERLAIN AND HOOKHAM v. SCOTT AND COMPANY.

DEAR SIR: We have had our attention drawn to a report on the above case in your issue of December 5th, headed "Curious Treatment of an Electric Meter," and would point out that the report is inaccurate and misleading.

The facts as given in evidence were that the installation was worked by the gardener (as is very often the case in private houses), but all the gardener had to do with the meter was to take the readings night and morning, which he did when the meter worked. Your reporter evidently understands very little of electricity, or he would not have accepted, as he appears to have done, Mr. Young's (counsel for the plaintiffs) opening statement, made in a jocular way, as serious evidence. The joke about using the meter as a "hot water pipe" was only funny from the absolute impossibility of doing as Mr. Young suggested. As a matter of fact, the gardener never touched the meter. The plaintiffs' engineer, Mr. Holden, very naturally found the meter switched off, as our instructions were that if the meter stopped working it was to be switched off and left so until we saw it, and the gardener faithfully carried out our instructions. Next, two witnesses, who were with the plaintiff's engineer when he examined the meter, swore that the meter did not work when first switched on by the engineer, but that it was only when some 30 amperes (a considerable current) were passing that it began to work. Further, your reporter does an injustice to Messrs. Chamberlain and Hookham. They never lowered themselves to suggest that the gardener either had or should manure the meter; this was only another "funniosity" in the opening statement of Mr. Young, and was not seriously put forward as evidence.

Again, our defence was not that the meter would not work, but that it was unreliable.

Our client, Mr. P. C. Gilchrist, a scientific and practical gentleman, well-known in connection with the "Gilchrist" process for producing steel, refuses to have this meter connected to the installation.

Your report is consequently so unfair and unjust to us that we must ask you to insert this letter in your next issue.—Yours, &c.,

MONTAGU J. SCOTT AND CO.

THE HEATING OF CONDUCTORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The articles now appearing in your columns, by Mr. A. E. Kennelly, on the "Heating of Conductors by Electric Currents," are most interesting and instructive—particularly so to myself.

When engaged with others in the autumn of 1887 upon a set of rules for the installation of electric light, we determined, if possible, to clearly define the limit of current to conductor, and in such a manner that tables could be compiled to meet it. Thanks to Prof. G. Forbes, we found this could only be attained by limiting the temperature of the conductor, due to current, to a certain number of degrees above air. Eventually the rule read as follows:—

"Conductors must be so proportioned to the current to be carried that in no case shall the temperature of the conductors exceed 18°F. (10°C.) above air."

As this limit has since been adopted by several of the fire offices, it is all the more satisfactory to find it confirmed by Mr. Kennelly, after a most careful investigation of the subject.

It is now evident beyond doubt that the limit is perfectly

Digitized by Google

safe, and at the same time gives full scope to the electrical engineer.

A table was subsequently drawn up from the formulæ of Prof. Forbes to meet the rule, but unfortunately it never received official sanction, owing to the doubt cast upon its reliability by Mr. Preece. It appears Mr. Preece discovered that some of the data relied upon by Prof. Forbes (dealing with the emission of heat) were not applicable to wires, hence the table was shelved pending further investigations. Mr. Preece, apparently, has been too much occupied of late to give the subject his further attention, a fact all the more regrettable, as he now finds himself forestalled.

Upon comparing the table referred to, as revised in May, 1888, with the table now issued by Mr. Kennelly at the instigation of the American fire offices, it will be found they practically agree for currents ranging up to 400 amperes. What difference exists is mainly due to the fact that the one allows for a greater thickness of insulation than the other. But when the specified diameters are converted into stranded cables of S.W.G., this difference absolutely vanishes.

In placing these facts before you, I cannot help regretting that, owing to the causes I have alluded to, the credit passes from this side of the water to the other—at least, so far as the fire offices are concerned.

But all honour to Mr. Kennelly. By a masterly treatment of the subject, he has now lifted it out of the region of theories into the region of facts; and I am well pleased to find the table and rules, in which I am interested, at length confirmed in so thorough a manner.—Yours, &c., H. HUMAN.

Guardian Fire Office, E.C., Dec. 23.

[An examination of the tables enclosed by our correspondent shows that they are practically alike.—ED. *E.*]

FLAMES AND ELECTRICITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As this subject is again being alluded to in your columns, I hope you will allow me to direct attention to some points which require to be observed.

Electrical experiments with flames have been of two kinds. First, some parties have inserted instruments within flames, with the view of trying to discover the electrical condition of flames; but this is not the kind of experiments at present referred to in your columns. Second, can the surface of a flame receive a charge of electricity as if it were a solid body, and if so, how does a flame act? This is the subject of inquiry at present. Now, I maintain that it is impossible to place a charge of electricity on the surface of a flame. The current of hot air which is continually rushing up the sides of a flame prevents the possibility of a charge of electricity remaining on the surface of a flame. Again, the reason why an ordinary gas-flame assumes a tall, erect position is because the current of heated air around it forces the flame into the perpendicular position. Hence, when an artificial current of air is made to move a gas-flame to one side, we have in the bent flame ocular proof that such a current of air is then existing, and it is the application of this to a current of air, set in motion by a current of electricity, which lets us know which way the current of electricity is moving. The discovery that an insulated gas-flame could be trusted for the above purpose was made by me in 1839, and has been formerly noticed in your columns. It is a mockery of this subject to hold a candle or a spirit lamp to an electrical machine. The flame to be employed must be free from smoke, and must be insulated. A properly regulated coal-gas flame burning at the end of a long glass tube, with a small point instead of a burner, answers the purpose well. The oneend of the tube should be pointed for the gas to burn at the other, and should be provided with a brass stop-cock for regulating the size of the flame, and the stop-cock should have a rubber tube to bring the gas. In choosing a glass tube for this purpose attention must be paid to the character of the glass, for there are some kinds of glass which allow electricity to pass through them as fast as if they were a piece of metal, and there is no glass made which is an absolute non-conductor of electricity.—Yours, &c., JAMES JOHNSTONE.

8, Mercheston-park, Edinburgh, Dec. 23, 1889.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning.*]

ELECTRIC LIGHTING TENDERS.—The municipality of the City of Florence, in accordance with a decision of the Town Council, propose to grant by tender, and without any privilege whatever, a concession for the production and transmission of the electric current both for purposes of illumination and motive-power, for the use of the public. Tenders for the said concession will be received up to February 15, 1890. The principal clauses and conditions of the said concession are as follows:—1st. All the conductors are to be underground; 2nd. The difference of potential between the earth and all those parts which may be touched by those making use of the current must be less than 150 volts. In the principal conductors placed underground, however, 1,000 volts may be used; 3rd. The concession shall last 40 years; 4th. Applicants for the concession shall send in documents to prove and show their having obtained and worked other similar concessions with satisfactory results, at the same time stating which system they intend adopting for the production and transmission of the electric current; 5th and 6th. In order that tenders sent in may be taken into consideration, a temporary deposit of 25,000 Italian lire in cash or in Italian Funds must be made. For all further information concerning the above concession, and, moreover, to obtain a copy of the conditions in full as deliberated upon and voted by the Municipal Council, it is necessary to apply to the Secretary of the Municipality, Palazzo Vecchio, Florence—"Segreteria del Comune di Firenze, Palazzo Vecchio."

——— Tenders for the installation of the electric light at Segovia in Spain are invited, and will be decided upon on January 7, 1890. Particulars may be obtained from the Minister of the Interior at Madrid and from the Municipality at Segovia, to either of whom tenders may be sent.

THE BRITANNIA COMPANY, COLCHESTER.—A circular recently issued by this Company contains an illustration of a new Horizontal Radial Drill for drilling flanges at ends of long pipes, or holes in any position in the vertical sides of machines or machine frames. The table for holding the work has T slots on top and one side, and carries a pair of V blocks for holding pipes up to 24in. diameter. Illustrations are also given of a Horizontal Boring, Drilling, and Surfacing Machine for large work, with steel spindles, capable of boring holes up to 24in. diameter, and fitted with pulleys and gearing giving eight changes of speed; a Shaping Machine, fitted with many recent improvements, the gearing being so situated that the operator has complete control without changing position; and a No. 27 Stud Chasing Lathe, with capstan rest, for the production of screwed studs, joint pins, and small fittings. By means of the rest, the lathe will turn, point, and chase by the one operation.

MESSRS. PATERSON AND COOPER.—We have received from this firm advance sheets of their new electric lighting catalogue. An instructive table of approximate outputs of the "Phœnix" dynamo will be found on page 8, and some useful "Notes" on page 4.

REMOVAL NOTICES.—Mr. Harry South, of 10, John-street, Adelphi, informs us that, owing to increase of business, he has taken larger offices and show rooms at 10 and 12, Garrick-street, Covent-garden, W.C., where he will remove as soon as the necessary alterations are completed.

——— Mr. A. P. Lundberg announces his removal from Bowling Green-lane, Farringdon-road, E.C., to larger premises. His new address is Bradbury Electrical Works, Bradbury-street, Kingsland, N.

CALENDARS AND NEW YEAR'S NOVELTIES.—We have received from the Direct United States Cable Company a calendar for 1890 of original, not to say "striking" design. It consists of a "fist" clenched over a bundle of electric wires. At the base is a paper pad with a removable slip for each day in the year. It is certainly an attractive advertisement.

——— From the Commercial Company comes a copy of their well-known circular calendar showing the route of the Mackay-Bennett cables. A useful office calendar and effective advertisement.

——— Messrs. Crompton and Co. (Limited) send an octavo blotter with triplicate calendar for 1889-1890-1891, and a very handy, full-sized blotting-pad for office use, with flap calendar and memoranda. This is an improvement upon last year's pad, and will keep Messrs. Crompton's manufactures prominently before the users of the calendar.

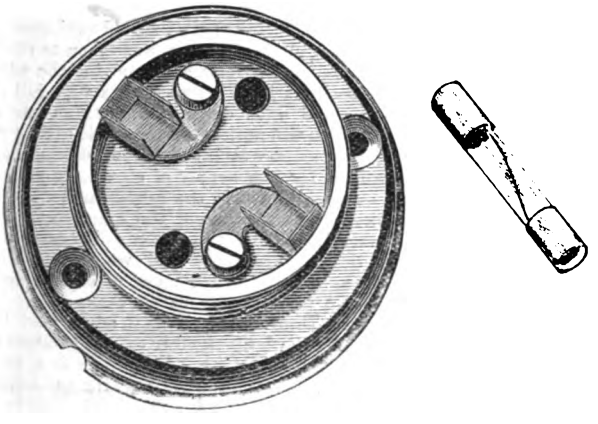
JOHN A. ROEBLING SONS, AND COMPANY.—The new price list just to hand contains illustrations of McIntire's Electric Wire Connectors and Terminals, for which the firm are the American agents. Illustrations are given of electric light and hand-drawn telegraph connectors, and combination, branch, and solder-and-rivet connectors, and dynamo battery lamp and cut-out terminals, tools, &c.

Digitized by Google

THE SCOTT INSTANTANEOUS FUSE.

One of the disadvantages of ordinary fuses is that they take some little time to act owing to their comparatively large mass, with the result that the current they will take momentarily on a short circuit before fusing is much greater than that which will fuse them when tried through resistances.

With a view to remove this defect a new fuse (see Figure), made of high conductivity wire, extremely fine, has recenly been brought out by Messrs. Laurence, Paris, and Scott. These fuses are of such small mass that the current through them on a short circuit never reaches anything like double what they will go at with a gradually increasing current. Repeated experiments with a fuse, intended to carry 1·5 amperes, show its fusing current, when gradually increased, to be from 2·25 to 2·6 amperes, and when short-circuited without appreciable resistance, through a magnetic cut-out, the latter must be adjusted to go at less than 4 amperes, before it will cut-out



at the same time as the fuse. Another experiment is to short-circuit the fuse through an ammeter, measuring up to 5 amperes, the needle simply giving a slight kick: a large ammeter is unaffected. Few people, with any regard for their instruments, would like to try this experiment with any ordinary fuse. The wire in these fuses is silver gilt. Another advantage of this fuse is the very good contact, the fine wire being soldered to the caps, and the caps making spring contact in three places on each cap in the fuse boxes. The fuse itself, though very fragile, is of a material that is unaffected by the atmosphere, and is so supported and enclosed that it is practically indestructible except by an excessive current. It is easily placed in the fuse box, and what is important from a fire insurance point of view, there is not the same facility for replacing a broken fuse by any handy bit of wire as there is with the ordinary fuse with terminal screws. There is also the 1in. break, usually stipulated for in fire insurance rules.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

December 9, 1889.

19,748. W. BROUGHTON. Manchester. Improvements in apparatus connected with incandescent electric lamps for the use of dentists, surgeons, and others.

19,794. A. P. TROTTER. London. A method of and apparatus for electrically reproducing designs at a distance.

December 10, 1889.

19,803. R. F. DEWHURST. London. Improvements in reflector adjusters for oil lamps, gas, or electric light.

19,831. C. M. DORMAN and R. A. SMITH. Manchester. Quick make and break electric switches.

19,835. M. PERLS and T. PERLS. London. Improvements in electrical signalling apparatus for the prevention of collisions between railway trains.

19,857. Sir C. T. FORBES, Bart. London. Improvements in secondary battery elements.

19,861. C. H. LOGAN. London. Improvements in secondary batteries.

19,875. N. NEWMAN. London. Improvements in electric gas lighters and extinguishers.

19,883. J. K. PUMPELLY and F. D. THOMASON. London. Improvements in electrical secondary batteries.

19,892. H. E. FOWLER. London. Improvements in machines or apparatus for welding metal by means of electricity.

19,899. W. P. THOMPSON. Liverpool. Improvements in or relating to electric batteries (M. W. Parrish, United States).

December 11, 1889.

19,946. O. D. LA DOW. London. Improvements in telegraph transmitters.

19,951. H. BAYLEY. London. Improvements in electrical switches.

December 12, 1889.

20,022. E. WILSON. London. A bi-planar electric switch.

December 13, 1889.

20,042. A. F. ST. GEORGE and A. ST. GEORGE. Redhill. Improved means for viewing distant and inaccessible objects by the aid of electricity.

20,059. C. R. G. SMYTHE and E. PAYNE. Glasgow. Improvements in and connected with electrical safety cut-outs and switches.

20,079. R. H. HUGHES and R. S. HUGHES. London. Improvements in fittings for outside and other electric lamps or lanterns.

20,032. R. T. TURNBULL. London. A method of and apparatus signalling numerals, letters, and other symbols by electric light.

20,105. G. L. HILLE. London. Improvements in electric batteries.

December 14, 1889.

20,106. G. L. HILLE. London. Improvements in and connected with electric batteries.

20,163. T. MACHIN. London. Improvements in propelling tricycles and other velocipedes by electricity.

SPECIFICATIONS PUBLISHED.

1888.

18,505. SHERIDAN (Culp). Electrical torches for lighting gas. (Price 8d.)

18,930. BLAMIRES and BLAMIRES. Electric apparatus for indicating when machines are in motion. (Price 8d.)

1889.

859. JACKSON and SINCLAIR. Telephonic apparatus. (Price 8d.)

1,101. LOWRIE and HALL. Underground electric mains. (Price 8d.)

1,167. LOWRIE and HALL. Electric circuit switches. (Price 11d.)

1,168. LOWRIE and HALL. Electric current switches. (Price 6d.)

5,816. LANGDON. Electric accumulators. (Price 8d.)

14,504. DOUGLAS and PARKER. Regulating electromotive force, &c. (Price 8d.)

16,036. IRISH. Galvanic batteries. (Price 8d.)

16,648. WHELESS and WHEATLEY. Electric railway. (Price 8d.)

16,662. SHAPLEIGH. Secondary batteries. (Price 8d.)

BOOKS, &c., RECEIVED.

"Calvert's Mechanics' Almanack for 1890." (London.)

"Fortschritte der Elektrotecknik." Edited by Dr. Karl Strecker. Vol. IV. (Berlin: Julius Springer.)

"Examples of Lathes, Apparatus, and Work." By the Author of "Lathes and Turning." (London: E. and F. N. Spon.)

"Mechanical Graphics: A Second Course in Mechanical Drawing." By George Halliday. (London: E. and F. N. Spon.)

CO-OPERATIVE TELEPHONES.

A meeting was held at the Memorial Hall, Manchester, on Monday last, for the purpose of receiving the report of a Committee appointed to consider the desirability of establishing a mutual economic system of telephones in Manchester and elsewhere. Mr. A. D. Provand, M.P., presided.

Mr. EDWIN GUTHRIE read the following report of the Committee:—

The Committee find that the principal patent (Bell's) will expire on December 9th next, and that no existing patents of any great importance will stand in the way of the free working of any new Company after that date. At present there are about 1,428 renters on the Telephone Exchange in Manchester and Salford. The rent paid in Manchester for the use of the Exchange telephone in most cases is £20 per annum. Conditional under-

Digitized by Google

takings have been received from more than 1,300 persons or firms to rent Exchange Telephones from the new Company at £5 per annum, and about 500 private telephones have also been applied for. The Committee are of opinion that the effect of the reduction from £20 to £5 would be to induce a very large increase in the number of users of the telephone, and these would in all probability shortly reach 4,000 to 5,000 Exchange renters, but in this report it is proposed to show the result upon the assumption of only 1,500 Exchange telephones of the new Company being rented in Manchester, and Manchester may be taken as a fair example of the probable results to be looked for in other towns. Your Committee find that the capital outlay to fully equip a plant for 1,500 Exchange renters, including 1,500 private instruments, and 500 extra private telephones, with two instruments each, would not exceed £18,000. The capital outlay for the equipment of 1,500 Exchange telephones, including the above estimated number of private telephones and extra instruments, would be about £12 per Exchange renter, against a capital outlay of the old companies of about £112 per renter, as exhibited by the last report and accounts of the Lancashire and Cheshire Telephonic Exchange Company (Limited). In comparing these two figures it must be observed that the estimates for the new Company are for a limit of one mile radius, while the other Company gives inter-town communication. For a larger number of telephones upon one Exchange, the capital outlay of the new Company would be certainly less than £10 per renter. Your Committee estimate the following to be the annual results of the working of the business upon the basis of 1,500 Exchange renters; on a larger number of renters the results would be proportionately more favourable—Income: 1,500 renters, at £5 per annum, for telephones within one mile, £7,500: 1,500 private instruments, at £1 each, £1,500; 500 private telephones, with two instruments, at £2 per annum, £1,000; total, £10,000. Expenditure: Rent, £300 to £500; manager, £300 to £500; assistants, £200 to £250; office sundries, £100; engineer, £300 to £500; 20 operators, 14s. each per week, £728; lady superintendent, £65 to £78; labour—six men and one boy maintaining wires, at £10 per week, £520; ten faultfinders, at 25s. per week, £650; materials and repairs, £500; way leaves and roof repairs, say £1,000 to £1,500; 10 per cent. to Government on income from Exchange wires, £750; sundries, including taxes, insurance, directors' remuneration, &c., £750; balance of income over expenditure, £3,837 to £2,674. Balance brought down, £3,837; less six per cent. dividend upon paid-up capital of £18,000, £1,080; leaving a balance available for reserve of £2,757, or not less than £1,594. The foregoing shows that a rent of £5 per annum would yield an ample return upon the capital outlay necessary to the equipment of an efficient telephone service for 1,500 Exchange renters. The actual working expenses of the National Telephone Company (Limited), and the accounts of the Dundee and District Telephone Company, which was absorbed by the National Company in 1885, proved the sufficiency of the estimates of income and expenditure. In explanation of the difference of the rent proposed to be charged by the new Company and the rent charged by the present Company operating in Manchester, it may be stated that the necessity for the larger charge of the old Companies is accounted for in part by the larger cost of equipment as compared with present contract prices, but in the main by the loading of the capital in respect of patent rights, concessions, and goodwill, the values of which are now about to expire. It is believed that a very large proportion of the capital of the telephone companies now quoted upon the Manchester Share List represents expenditure other than on the material equipment of the telephone service. As the proposed Company will have no extraordinary expenditure whatever, a capital of under £20,000 will answer all the estimated needs of the local service contemplated, while any increasing needs will always be represented by corresponding material value, whether by extension within the city of Manchester or in other parts of the district or elsewhere in the country. The Committee recommend as follows:—That a Company be formed under the Companies Acts with limited liability; that the registered capital in the first instance be £100,000 in £10 shares; that in the first instance £20,000 be issued for the purpose of providing for the proposed outlay in Manchester; that the headquarters of the Company be in London, with a central board there; that there be a local board of three persons in Manchester, and in each provincial district; that the co-operative or mutual system be recognised as the basis of the Company; that dividends be limited to 6 per cent. per annum upon the paid-up capital of the Company; that should the proposed rental of £5 yield a larger revenue than may prove necessary for the working of the Company and the creation of a sufficient reserve fund, the renters should have the benefit in a reduction of the rent of the telephones or the improvement of the service; that a committee be appointed and empowered to carry these recommendations into effect.—(Signed) Alex. Forrest, H. T. Gaddum, J. E. Longson, Edwin Guthrie, W. M. Mollison, W. Thomson, and Wm. Wadsworth."

The CHAIRMAN said the report afforded complete confirmation of the figures which were given in the preliminary circular issued to the commercial men of the city.

Mr. BILLING said he was positive that no system could work in Manchester with a subscription of less £10. He thought it was a great mistake to put forward estimates like those in the report, which he was assured would be doubled when the Company began operations.

Mr. GUTHRIE replied to this statement, and showed from an analysis of the working expenses of the National Telephone Company that the estimates were to be relied upon.

In answer to a question whether it was intended to make the interests of the users and the interests of the shareholders identical, the Chairman said it was particularly desirable that the renters should be shareholders, in order that there might be no conflicting interests in reference to the management of the Company's affairs.

On a question being asked as to the permission of the Corporation to erect additional wires, the Chairman said they had not yet approached the Corporation on the subject. When the Company existed they would see the authorities with reference to the matter.

Mr. PORTER moved—

"*That Messrs. J. S. Dods, Alderman Forrest, H. T. Gaddum, Edwin Guthrie, E. A. Hague, George Hahlo, J. E. Longson, W. M. Mollison, A. D. Provand, William Thomson, and William Wadsworth be appointed a committee to carry into effect the recommendations contained in the report submitted to this meeting.*"

Mr. HEWITT seconded the resolution, and it was carried unanimously.

A vote of thanks was passed to Mr. Provand for presiding, and the meeting terminated.

COMPANIES' MEETINGS & REPORTS.

Metropolitan Electric Supply Company (Limited).

Sir John Pender, K.C.M.G., presided over the second ordinary general meeting of this Company, which was held at Winchester House, Old Broad-street, on the 20th inst.

The SECRETARY (Mr. E. Cunliffe Owen) read the advertisement convening the meeting, and the report of the Directors was taken as read.

The CHAIRMAN, in the course of his remarks in moving the adoption of the report, said: The shareholders have before them a very full report of the work we have been engaged upon during the financial year which ended on September 30th last. You will notice that the whole of that period was taken up in obtaining parliamentary sanction for our schemes, and in the erection of central stations for the supply of electricity within the districts which have been allotted to us by the Legislature. We must, therefore, look upon this period as one wherein the foundations of our future success have been firmly laid, and I think you will share with the Board the conviction that this success is assured when you consider the large and important areas we are called upon to supply, and the enormous demand for the light which meets us on every side. As an illustration of the importance of our areas, I may state that it has been estimated that, putting aside the large number of non-residents who are employed in these districts during business hours, there is a resident population of upwards of 300,000. I am informed that the gas consumed in these areas represents a revenue of £337,506 a year, and, granting that we take from the gas companies a portion only of the lighting, we have every reason to anticipate a handsome income. Although we must look upon the past year as preparatory, it is satisfactory that during that period we earned a sum of £6,127. This amount was chiefly received from the supply of light at our Whitehall station. We have thought it prudent to place that sum towards the reduction of the general expenditure of the year, so that we may be enabled to start the present financial year with a comparatively clean sheet. Practically, the whole of the expenditure last year was capital expenditure, and we shall therefore have the full benefit now of the productive powers of those stations which are now completed. Full reference is made in the report to our Parliamentary history. The Board of Trade, acting under the powers conferred upon them by Parliament, decided to hold an inquiry into the various Provisional Orders and licences applied for by this and other companies. The inquiry lasted through the month of April, and was conducted by Major Marindin, and it formed a most important epoch in the history of electric-lighting enterprise. A vast amount of evidence was given, and the different systems proposed to be adopted were exhaustively discussed. In the evidence which I then gave, I stated that I should not consider this Company a great success until we had quadrupled our present capital. I am still of that opinion, and when I tell you that the total amount of capital embarked on the supply of electricity in London barely amounts to £3,000,000, whereas the capital of the metropolitan gas companies amounts to upwards of £13,500,000, I do not think you will accuse me of exaggeration. The result of the Board of Trade inquiry was that that body recommended Parliament to grant us rights in the areas mentioned in the report. The Board are of opinion that the areas—including, as they practically do, the whole of the theatres, and so many of the most important restaurants and public halls and buildings, the shops in Oxford-street and Holborn and the Strand, the offices in Chancery-lane, Lincoln's-inn, and elsewhere, and the valuable residential districts of Bloomsbury and Marylebone—are amongst the best in London, and will give us ample scope for our work. Moreover, it is satisfactory to note that to avoid the public inconvenience of frequently breaking up the streets, the Board of Trade have laid down the principle of only recommending for admission two companies using different systems into one area. If this principle is adhered to, future competition will be limited in extent—to the advantage, I think, both of ourselves and the public. At present we have only competition in a small portion of St. Martin's, and that has not affected us in any way. There are, however, two or three small companies at present supplying a certain amount of light in portions of the areas of this Company, and the Board are remonstrating with the authorities as to the unfairness of such competition, and we hope to be able to obtain the protection due to us as authorised undertakers from interlopers of this nature. The shareholders will understand that during these proceedings before the Board of Trade—and, indeed, until the recommendations they made had been confirmed by Parliament—we did not feel justified in completing our system of supply. As an instance of the uncertainty of our position during that period I may mention our Eccleston-place property, to which reference is made in the accounts. We purchased this site in February last, before the inquiry was commenced, for the purpose of supplying light in the districts of St. George's, Hanover-square, St. James's, Piccadilly, and Westminster. Owing to the decision of the Board of Trade we have been unable to utilise this site as we

Digitized by Google

intended, but we are in treaty for its disposal, and we hope to effect a satisfactory re-sale in a short time. The Royal assent was given to our Acts on September 2nd last. Since that time we have had authority to lay down mains and complete our system, and I think I shall be able to show you that the Board have lost no time in making use of the privileges they are now possessed of. I will now review our present position and prospects, and in the first place I will describe the stations we have erected and are erecting. As to the Whitehall station, when I last addressed the shareholders I stated that we were about to light some of the large hotels in the neighbourhood of that station. One of those hotels, the Hotel Victoria, we have been lighting ever since. In regard, however, to the others, the terms offered were so unremunerative and would have formed so bad a precedent that we considered it more prudent to decline them. From what I learn, however, people in these cases are, when a good installation is established, ready to give up their small installations in favour of the larger one. Besides these hotels, we have now been lighting for some time a number of buildings, among others the Avenue Theatre, the Turkish Baths, Hampton and Sons, St. Martin's Church, St. Martin's Vestry Hall, and the Garrick Theatre. We have also commenced to supply light to the huge block of buildings known as Whitehall Court. When those buildings are lighted—and they are now fast approaching completion—they will absorb the whole of the surplus light of that station. The Company hold a firm contract for the lighting of the whole of that gigantic block. The installation for the station at Sardinia-street, Lincoln's-inn-fields, was furnished and erected by the Westinghouse Electric Company, and you will be pleased to hear that the machinery has fulfilled all requirements, and has been working most satisfactorily; and from that time to the present there has been no hitch or failure in the supply of light to that or any other of the buildings we supply. We have taken on a total of 7,000 lights since the date of the opening, September 21st, and I think you will agree with me that that is not bad work for 13 weeks, considering that the cables had all to be run underground. I may explain that we were not permitted to open the streets until the Act was passed. Among the buildings we are now supplying from that station are the Gaiety Theatre, Holborn Restaurant, the Royal College of Surgeons, Exeter Hall, and many offices. I am told (but I have not been to see it) that the Holborn Restaurant is one of the most brilliantly lighted in London. In addition to this, we are under contract to supply a further 5,000 lights by the end of the year, including Drury Lane Theatre, the Government Record Office, Hansard's Publishing Union, Messrs. W. H. Smith's offices, Terry's Theatre, and various hotels, offices, and private residences. When all these lights have been taken on it may be considered that the present output of the station will be fully occupied. We have, therefore, determined to increase the capacity of the station by more than double, which can be done without further extension of buildings, and as we hold contracts for at least 6,000 lights, I have no hesitation in saying that this second installation will be fully taken up before its completion. I will now refer to the Rathbone-place station. The Board determined in February last to purchase a small station on this site as a going concern; but as the existing plant was small, and the demand for light in the district was very large, they accepted a tender of the Electric Construction Corporation for the erection of a powerful alternate-current plant. The first portion of the plant has now just commenced running, and its light-giving capacity is fully taken up. As soon as the plant is all at work—and we hope this will be early in March—we have in our possession contracts which will charge it to its full capacity, so that here again we shall be earning a maximum revenue as soon as the station can be got to run. With regard to South-mews station, which is to supply the western division of Marylebone, we have acquired a fine site behind Manchester square, the buildings on which are now nearly completed, and are practically ready to receive the machinery. The Electric Construction Corporation are supplying the plant for that station, and we are assured that it will be completed in April next. I am happy to state that there again we look forward to the best results, as no less than 50 per cent. of the gross output has already been applied for. As regards the Waterloo Wharf, we had accepted a tender from Messrs Johnson and Phillips to erect an alternate-current station on their site at Waterloo Wharf. Owing to negotiations with the London County Council we have not yet commenced to erect the buildings, but the machinery is in a forward state. We are also about to erect a station in the Strand district; and if we obtain the necessary powers we shall erect stations to supply Paddington and the western portion of the City area. We are also considering the advisability of erecting a separate station to supply Bloomsbury and Holborn, in view of the fact that the Sardinia-street station will prove inadequate for the requirements of these districts. It must be remembered that the erection of these stations involves also the laying down of the necessary mains, and this is by no means the least arduous part of our undertaking. We have already laid four miles of the underground mains from Sardinia-street, with very successful results, and we shall have eventually a complete network of underground mains traversing the whole of our district, extending over 35 miles. As, however, a considerable time must elapse before this work can be satisfactorily completed, and as it is impossible now to run any new overhead mains, the Directors have succeeded in coming to an arrangement with the London Electric Supply Corporation, whereby that Company has agreed on reasonable terms to hand over their existing overhead cables in districts allotted to this Company, but previously supplied by them, thus immediately enabling us to obtain a large revenue. I may tell you that we are working on the most friendly terms with the London Company, and we help one another when we can. I have always held that the less friction the better the machine. There is employment for their capital as well as ours. You will probably wish to know something about our present and future revenue. Our manager, Mr. Claremont, has reported that we are at present supplying about 15,000 lights from Whitehall, Sardinia-street, and Rathbone-place, and that he estimates that that will produce a revenue of about £20,000 a-year. He also states that that will be almost immediately increased to about 30,000 lights, with an estimated revenue of over £30,000 a year.

A SHAREHOLDER: Net?

The CHAIRMAN: No, gross. When the second installation at Sardinia-street is finished, the Rathbone place station fully equipped, and the Manchester-square station opened, we shall be in a position to supply from those four stations, allowing for a reserve of spare power, about 80,000 lights, with an estimated revenue of £89,250. As to these figures, you must consider that they are more or less based on the experience we have gathered of other installations in other places, and we believe those which I have given you to be as nearly correct as possible. We are dealing with a new business, and it is extremely difficult to get absolutely reliable estimates, but I think I can safely say that when our present capital of £500,000 is fully employed, we shall be supplying not less than 100,000 lights, and that our revenue will be at least £100,000 per annum. I believe that by the spring we shall have not only the whole of the capital engaged, but the whole of the installations I have indicated thoroughly at work, and producing very satisfactory results. I may further state that, as far as we can ascertain, the experience of gas and long-established electric companies goes to prove that there is only 60 per cent. of productive power used at any one time, and that 40 per cent. may thus be said to be in abeyance. We have based all our calculations on the maximum power being required, and therefore if experience and practice show that we have this 40 per cent. to spare, and can safely use it, it will give us a large additional revenue. In the autumn Mr. Edison paid me a visit and went over the Company's installations that were then established, and his observation was that the Board were applying the science of electricity in a thoroughly practical way, that they were not putting too many eggs in one basket, and that they were doing that which could not fail to be a success. Mr. Edison said that of all the cities in the world he knew of, there was no city that offered such a grand field for electric lighting as London, with its large areas and a great and comparatively rich population, and, at the same time, the worst weather that was to be found in the world. Mr. Edison therefore expressed his opinion that electricity would become positively a necessity in London more than in any other city. I have received a telegram this morning from Mr. Edison, who says, as to electric light companies in the United States: "Sixty companies earn from 6 to 20 per cent. Large numbers of them put earnings into extensions, owing to short capitalisation." In America, I may explain, they have comparatively small capitals, and as their requirements grow they put earnings into extension, and after they arrive at a certain point they generally add a considerable amount of "watered" capital, probably 25 to 30 per cent., so that the dividends now being paid in America of from 6 to 20 per cent. are actually paid upon the amount of "watered" capital as well. Otherwise, as Mr. Edison remarked, the dividends would seem too great, and too much competition might thus be created. Mr. Edison in his telegram goes into details of some special cases, and says, "Boston—capital $1,500,000, earns 13 per cent. this year; Harrisburg—capital $125,000, pays 20 per cent.; Reading—capital $130,000, pays 18 per cent.; New Bedford—capital $150,000, pays 6 per cent.; Rochester—capital $225,000, pays 8 per cent.; St. Paul—capital $250,000, pays 8 per cent.; Washington—capital $300,000, pays 6 per cent." Then Mr. Edison adds, "All our companies capitalised at between 25 and 30 per cent. more than actual cash invested." That shows you, gentlemen, pretty much what is being done elsewhere. London is at the present time a city of all cities in the world that is behindhand in electric lighting enterprise. However, we are now entering upon a new departure with a considerable amount of energy, and I consider that it will be a grave reflection upon the Directors and upon the scientific and practical men of London if they cannot do their work as well as it is done in other countries. I have the strongest possible belief that we are entering upon a successful career, and that our property, as a lighting property, will develop in as great a degree as gas has done. Therefore, with all confidence, I say that we have a great thing in hand. If people tell you that this is a flash in the pan, do not believe it. I advise you to stick to your shares, and you will find that you have a wonderfully good and promising investment. Some of my friends have told me that they have been advised that the thing cannot go on, there being no dividend this year. It was impossible to create and erect installations as we have been doing, and have them all running and earning dividends before the works were thoroughly established. We must have time to establish works, and our works are now in such a position that they will very shortly be producing very largely. At the same time, I have shown you that we cannot even now produce enough for the demand. I have received a telegram this morning from Berlin—a city which is very well and satisfactorily lighted—which states that the company in Berlin is paying 9 per cent. per annum, and that they expect a very large increase upon that, as they are now getting their stations into full operation. I think I mentioned to you at our last meeting that Sir George Elliot, Sir James Anderson, and other gentlemen on our Board had been for a long time closely connected with electricity, which we have shown has become a great power and a great benefactor. I think you will find from Lord Salisbury's speech the other day that he inferred that it had been probably the greatest factor in human progress in his time. When the Board took up this question of electric lighting they did so from a conviction that the time had come to do it. A great deal of money has been spent in speculative purposes, and a great deal of excitement was then caused. That has passed away, and in its place you have solid work. You are now getting real value for your money. I have great pleasure in reading you a telegram from Sir George Elliot, who would have been here to-day only he was called away to Egypt, and he sends me this telegram, dated Port Said, the 20th:—"Your general meeting of Metropolitan Electric Company takes place this day. This despatch is to express my regret at my inability to be present, and to add that, should you deem it necessary, you may state that, had I been present,

Digitized by Google

I should have expressed my opinion and belief in the prospects and solidity of the Company, and that with courage and patience the shareholders will be well satisfied with their undertaking and its dividend." Continuing, the Chairman said: I think I have now told you everything I know myself, and my views are unchanged. I hold the very strongest opinion that we are on the right road, and we are determined to pursue it with energy. I hope that when I have the pleasure of meeting you again you will bear in mind the remarks I have made to day. It will take some time to complete the works now contracted for, and to fully expend the money which has been subscribed. As soon as we require money we intend to put out a certain amount of debentures. I believe that we shall be able to get debentures at a low rate of interest, and if this is done it will be of great benefit to the shareholders. In the event of our requiring more capital, we shall come to the shareholders first and give them the advantage of taking up the new shares. I believe our property will become a very important one, and that those who hold on to their shares will reap the reward I have indicated. He then moved—

"*That the report of the Directors and the statement of accounts to September 30, 1889, submitted to this meeting, be and the same are hereby received and adopted.*"

Alderman Sir R. N. FOWLER, M.P., in seconding the motion, observed that it was unnecessary for him to add anything to the full remarks which had just been made by the Chairman. He only wished to emphasise the statement that until the Royal Assent was received to their Act they were not able to commence business, or take proceedings for beginning business; and therefore, as the shareholders would see, the Company had not had, until quite recently, an opportunity of earning a profit. Therefore what had already been done must be regarded as having been accomplished in a very short time, and not as a year's work.

Mr. BIGWOOD said that he was a stockbroker, and that balance-sheets played an important part in his profession. They had to be watched before advice could be given to his clients. He had looked into the balance sheet of this Company, and he had been amused at the entry of "sundry credit balances." Sundry debtors stood at £9,522. 18s. 3d., which was in favour of the Company, and was correctly expressed. When, however, he looked on the other side for "sundry creditors," he found "sundry credit balances," £42,305. 1s. 11d. He did not know what "sundry credit balances" meant, and he thought it was misleading. He also saw that they had borrowed from the bank £10,000, on which, of course, they paid interest, while on the other side they had at the bank £9,900, for which he presumed they received no interest. He also considered that the items of "Parliamentary expenses and Board of Trade inquiry £4,800," and "office furniture £670," showed a want of economy on the part of the Board. He wished the Company every success, and of its ultimate success he had not the least doubt.

Mr. GILES, M.P., said he considered the Chairman's statement very satisfactory as regarded the progress of the Company. It was clear that, as they only received the Royal Assent so recently, they could have done very little up to the present time in the way of earning money. He could not help thinking that the expenditure upon what they had already completed was very small. The shares were now standing at a good price, and it seemed to him a pity that the remainder were not issued.

Mr. HENDERSON inquired whether the overhead wires would have to be removed and replaced by others underground. He also inquired whether the shareholders would have an opportunity of paying up in full the balance due on their shares.

The CHAIRMAN, in reply, stated that practically all the expenditure that was incurred last year ought to go to the cost of the installations—that was to say, expenditure on capital account. As to the money they had borrowed, they were owing money to parties who had furnished them with installations, and they had not been in a hurry to pay so long as they were not pressed. They had, however, to be satisfied that the money was in hand if they should require it, and therefore they arranged with their bankers, who had perfect confidence in the Company, to place a certain amount of money at their disposal if they needed it This had been done, in order not to press unduly upon the shareholders for calls until the installations were at work, and the Directors could show that the money had so far been expended, and that the prospect of getting a return on it was not very distant. If, too, they had made calls, they might have depreciated the market value of the shares. He hoped Mr. Bigwood would see, from what he had now said, that the Directors, in what they were doing, were endeavouring to make this a class of property in which the public generally could have an interest and confidence. They did not issue the remaining shares because they believed that when they paid a decent dividend—which he hoped to do at no distant date—they would be able to borrow money at a very moderate rate; and they would see how much that would add to the value of their shares. They were trying to make the undertaking popular with the shareholders. As to overhead wires, the Government had laid down a law that they must be dispensed with in two years time. All the wires they were laying were underground. They had, however, as he had said, bought a certain amount of overhead wires from the London Company. He did not know that those wires would have to be taken down in two years, but if so, the Metropolitan Company would have had the benefit of them in the meantime, and he might say that they had been acquired on terms which made their purchase a good bargain. Their accounts, under the Act, would have to be made up to December 31st in each year, and they would have to issue supplementary accounts to the end of this year. When they did that they would also deal with the larger question of finance; and in sending out the statement they would intimate whether the shares might be paid up in full or not. It would create a little irregularity, but they were very anxious to meet the wishes of the shareholders on every point so far as they could do so. He then put the motion, which was carried unanimously.

The Auditors—Messrs. Deloitte, Dever, Griffiths, and Co.—having been re-elected,

The CHAIRMAN stated that, in the interests of the shareholders, a system had been established by which there was not only the usual audit, but a constant audit. They had also thought that the Company ought to have the most able and the best auditors who could be found, and he believed that Messrs. Deloitte, Dever, Griffiths, and Co. were second to none.

Mr. GILES, M.P., then proposed a vote of thanks to the Chairman and Directors. He quite agreed with the Chairman's remark that Englishmen ought to do as well with the electric light as had been done elsewhere. Looking at the list of Directors of the Company, he felt quite sure that they were competent men of business, and that they would make the concern as great a success as any body of men could do. He hoped they would not be shy in asking for more money when they required it.

The motion was seconded by Mr. BLANDY, who said that Sir William Thomson, the great electrician, in reply to questions put by him (the speaker) respecting the Company, said: I am only their consulting engineer, and I cannot say what the Company may be financially. But I know the people whose names are on the Board, and I know what splendid work Sir John Pender, Sir James Anderson, and Sir George Richards have done for the Eastern Telegraph Company, and that if the Company can be made a success you may consider that it will be.

The motion was carried unanimously.

The CHAIRMAN, in reply, said that the Directors were working with the greatest possible desire to make the Company a success. It was more than a question of money. They had, in fact, the greatest stimulus that men could have to carry out successfully an enterprise which he believed would have an important influence on this great City, and to show to other countries that Englishmen were not behind them in taking advantage of both scientific and mechanical progress. With the support of the shareholders, they hoped to carry the undertaking to a very successful issue.

The meeting then separated.

PATENT
SILICIUM BRONZE AND SILICIUM COPPER WIRE.
The best for overhead Telephone and Telegraph Lines,
AND ALL ELECTRICAL PURPOSES.
Hard Drawn High Conductivity Copper Wire.
ROLLED AND DRAWN
PHOSPHOR BRONZE.
PHOSPHOR BRONZE
BEARINGS, BUSHES,
AND OTHER PARTS OF
ELECTRICAL MACHINERY.
SOLE PROPRIETORS of the British, Indian and Colonial Patents,
THE PHOSPHOR BRONZE COMPANY (Limited),
87, Sumner Street, Southwark, London, S.E.
WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

Digitized by Google

The Phonopore Syndicate.

A meeting of this Syndicate was held on Tuesday last, at the City Terminus Hotel, Cannon-street, Mr. Henry Kimber, M.P., in the chair.

The SECRETARY (Mr. Henry Parminter) having read the notice convening the meeting,

The CHAIRMAN said, in moving the adoption of the report, they recorded that day the accomplishment of the practical working of one of the greatest strides in telegraphic work which this century had yet seen. This meeting, with the exception of the statutory meeting, was the first ordinary meeting of the Syndicate, which commenced in a very modest way in a meeting under the presidency of his colleague, Mr. Philbrick, Q.C., at his chambers only two years ago. Then a few of them put some private capital together to co-operate with the inventor, Mr. Langdon-Davies, in proving the practical working and developing of his invention. His old friend, the late Sir Charles Wheatstone, was wont to describe inventions of this kind by referring to the portion of a century over which the discovery might be deemed to have been developed. He well remembered the completion of the Gramme machine, which, Sir Charles remarked, was an advance of a quarter of a century in electrical science, and he made the same remark with regard to his own fast-speed automatic telegraph, which accomplished from 415 to 420 words per minute. What Sir Charles Wheatstone would have said when they were now able to show that not only could that speed be attained and one message telegraphically sent at great speed, but a large number of messages could be in course of transmission by different operators without retarding the speed and without breaking down. He was inclined to think he would have said it was a stride of something more than a quarter of a century. They had proved by the testimony which had been laid before them that the phonopore was by far the best kind of multiplex telegraph hitherto discovered. It was not so likely to be thrown out of adjustment, and, when it was, easily capable, by the commonest operator, of being readjusted, and required no scientific aid for its readjustment. He might just refer to a paragraph in the report stating that there had been a demonstration in Spain, perhaps the most practical and decisive of all, under Government inspection, over a variety of ordinary telegraph lines from Madrid, through Saragossa, Barcelona, Taragona, Valencia, Teruel, Cuenca, and back through Madrid on to Guadalajara, a distance of 1,700 kilometres, or 1,065 English miles. It was impossible to overestimate the value and significance of the high success thus obtained. They had good testimony as to the value of this invention from the visitors to Mowbray House. Most of these visitors also went to St. Pancras, where they were allowed, by the courtesy of the Midland directors, to put up an installation between that station and Leicester, a distance of 99¼ miles. Sir Frederick Bramwell, President of the Royal Institution, had visited both places, and in his report to a gentleman who had asked him to examine the system, he stated that all of the things claimed to have been accomplished by the phonopore had been accomplished in his presence and to his satisfaction. He was informed by Mr. Langdon-Davies that he had been requested to read a Paper on the subject at the Royal Institution, and if Mr. Davies was unable to read his Paper the President had offered to read it for him if he would lend the necessary instruments. They had found it advisable to purchase another patent from Mr. Langdon-Davies, called the rate-governor. He would not go into any scientific details, but it was a very valuable invention.

Mr. LANGDON-DAVIES, at the request of the Chairman, made a few remarks, and stated that one of the most important of the experiments made proved that the Phonopore Telegraph could be worked upon submarine cable lines. This was proved from the fact that when he was at the Hague he put the instrument there in connection with the cable crossing the North Sea to the English shores. The England end of this cable was joined to another cable, which again crossed the North Sea back to Holland, and the Dutch end of this cable was connected with Amsterdam. The Phonopore telegraph was worked on this cable in connection with the ordinary telegraph between Amsterdam and the Hague, passing twice across the North Sea *vid* England, and duplex working was obtained. Other experiments were made, which showed that the Phonopore system could be successfully applied to cables of various lengths, and he saw no reason why, if, as they had already proved, it would answer on cables 200 miles long, it should not as successfully work on cables 2,000 miles long. So satisfactory were the experiments that approaches had since been made by the administration of the Government telegraphs in Holland and the representatives of the State railways and the Dutch railways, for the adoption of the phonopore by those lines, who had decided to adopt it.

The CHAIRMAN then moved the adoption of the report.

Dr. BAINES seconded the motion, which was agreed to.

On the motion of the CHAIRMAN, seconded by Mr. E. H. POLLARD, Messrs. A. B. Isaac and F. A. Philbrick, Q.C., were re-elected Directors.

The Auditors having been elected,

Mr. POLLARD said they were not previously aware of what Mr. Langdon-Davies had to tell them as to the result of the experiments in Holland, and such intelligence as had been given to them could not be allowed to pass without some recognition at the hands of the shareholders. He would ask them to respond heartily to the proposal he had to make, and that was that a vote of thanks be recorded on the minutes of that, the first annual regular meeting, to Mr. Langdon-Davies for his untiring efforts, and for the splendid results he had obtained.

Mr. PHILBRICK, Q.C., seconded the resolution, which was carried unanimously.

Mr. LANGDON-DAVIES briefly replied, expressing his belief that he would be able to announce as satisfactory results over 2,000 miles as he had achieved over 200 miles of cable.

Mr. LANGDON-DAVIES proposed a vote of confidence in the committee and secretary, which was carried, and the meeting terminated.

NEW COMPANIES REGISTERED.

NORTH AFRICAN GAS SYNDICATE (LIMITED).—Registered by H. C. Eliott, 143, Cannon-street, E.C., with a capital of £30,000 in £1 shares. Object: to carry on the business of a gas or electric light company in the towns of Algeria and other parts of Northern Africa. There shall not be less than three nor more than five directors, the first to be appointed by the signatories. Qualification, £100. Remuneration, £50 each, and 10 per cent. on net profits after 10 per cent. dividend.

WREXHAM AND DISTRICT ELECTRIC SUPPLY.—This Company is registered with the object of forming centres in Wrexham, or within the surrounding hundred of Bromfield, both in Denbighshire or elsewhere, for the generation and supply of electric power, and the lighting of public and private buildings. Capital, £20,000 in £5 shares. Registered, December 19th, by Abbott Jenkins and Co., 8, New Inn, Strand, agents for Lewis and Son, Wrexham.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended December 20th amounted to £5,644.

EASTERN AND SOUTH AFRICAN TELEGRAPH COMPANY (LIMITED).—The Directors notify that the coupons due on January 1st on their Five per Cent. Mortgage Debentures will be paid on and after that date at the banking house of Messrs. Barclay, Bevan, and Company, 54, Lombard-street, E.C. Coupons should be left three clear days for examination.

HALIFAX AND BERMUDAS CABLE COMPANY.—The coupons of the Four and a Half per Cent. Debentures of this Company, due on the 31st inst., are payable on and after that date at the banking house of Messrs. Dimsdale, Fowler, Barnard, and Dimsdales, 60, Cornhill.

WEST AFRICAN TELEGRAPH COMPANY—The Board of this Company announce the payment, on January 1st next, of an interim dividend of 3s. 6d. per share for the six months ended June 30th last.

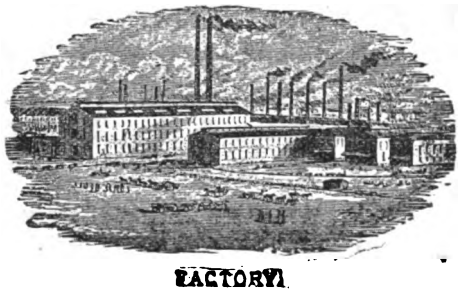
WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended December 20th, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £4,048.

STOCK EXCHANGE.—The Committee have appointed Saturday, the 28th inst., as special settling day in the Brush Electrical Engineering Company (Limited), ordinary shares (Nos. 1 to 63,416) and Preference shares (Nos. 1 to 63,416), and the National Telephone Company (Limited), First Preference Shares (Nos. 1 to 15,000) and Second Preference Shares (Nos. 1 to 15,000); and they have ordered these securities to be quoted in the Official List.

THE NON-CONDUCTOR OF ELECTRICITY.

VULCANISED FIBRE,
PATENTED.

This new material is supplied in two qualities, Flexible and Hard.
The FLEXIBLE is a substitute for Leather, Rubber, Gutta Percha, &c., and is extensively used by Brass Founders, Axle Makers, Hydraulic, Sanitary, and other Engineers, Pump Makers, Carriage Builders, &c.
It makes the best Hot and Cold Water Packings, and for Axle Washers of all kinds it is unequalled.
The HARD is a substitute for Metals, Hard Wood, Ivory, Vulcanite, Ebonite, &c., and is a good Insulator.
Sold in sheets, 5ft. 6in. by 2ft. 6in., varying in thickness from 1-50in. to 1in.



FLEXIBLE, 2/- per lb.; HARD, 2/3 per lb.

MOSSES & MITCHELL, 70 Chiswell-st., London, E.C.

Digitized by Google

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Monday, Dec. 23, 1889.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending Dec. 23, 1889.	
					£ s. d.		Highest.	Lowest.
			TELEGRAPHS.					
£ 1,770,360	Stock	12/6	Anglo-American	51½ 52⅝	...	Jan., Apr., July, Oct.	52½	51⅝
2,614,820	Stock	25/0	Do. Preferred	87 88	...	,, ,,	88	87½
2,614,820	Stock	...	Do. Deferred	17 17½	...	February	...	...
130,000	£10	4/0	Brazilian Submarine	12½ 13	5 15 5	Mar., June, Oct., Dec.	12⅝	12½
112,900	£100	5%	Do. 5 per Cent. Bonds	102 104	4 16 2	January and July	...	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	106 109	4 11 9	June and December.	...	...
16,000	10	9/0	Cuba Submarine	14⅛ 15	6 0 0	February and August	...	...
6,000	10	10/0	Do. Preference 10%	19½ 20½	4 19 9	,, ,,	...	...
12,931	5	2/0	Direct Spanish (£4 paid)	4 4½	4 8 11	March & September	4⅝	...
6,000	5	5/0	Do. Preference 10%	9 10	5 0 0	April and October	...	...
60,710	20	3/6	Direct United States	10 10⅛	6 13 4	Jan., Apr., July, Oct.	...	...
380,000	10	2/6	Eastern	14 14½	4 11 3	,, ,,	14½	14⅛
70,000	10	3/0	Do. 6 per Cent. Preference	15¼ 15⅝	3 16 2	,, ,,	15⅝	...
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock	105 107	3 14 9	May and November.	106¼	105
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	107 110	4 10 11	February & August	...	...
250,000	10	2/6	Eastern Extension	13⅜ 14	4 12 10	Jan., Apr., July, Oct.	14	13⅞
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	102 104	3 16 1	February & August	...	...
473,000	100	5%	Do. 5 per Ct. (Austrln. Gov. Sub.) Debs. 1900	104 107	...	January and July	...	...
179,177	10	2/0	Globe Telegraph and Trust	8⅝ 8⅞	5 3 9	Jan., Apr., July, Oct.	8⅞	8⅝
178,992	10	3/0	Do. 6 per Cent. Preference	14⅜ 14⅝	4 0 8	,, ,,	14⅝	14⅛
150,000	10	5/0	Great Northern	15⅞ 16⅛	4 12 4	Jan., July, and April	16⅛	16⅛
17,000	25	12/6	Indo-European	41 43	5 16 3	April and October	...	...
9,000	8	4/0	Reuter's	7 7½	5 6 5	April and October	...	...
15,609	10	5/0	West African Telegraph	9½ 10⅜	...	...	...	...
300,000	100	5%	Do. 5 per Cent. Debentures	99 102	4 18 0	March & September	101⅛	...
30,000	10	5/0	West Coast of America	11 11⅛	..	January and July	...	...
150,000	100	8%	Do. Debentures 8%	123 128	6 5 0	June and December	...	...
88,321	10	nil.	West India and Panama	2⅞ 3⅛	...	...	...	...
34,563	10	12/0	Do. 1st Preference 6%	11½ 12	...	April and October	11⅛	...
4,669	10	10/0	Do. 6 per Cent. 2nd Preference	14⅛ 15⅜	...	...	...	...
45,181	15	6/0	Western Brazilian	9¾ 10¼	7 6 5	May & November	10 1/16	9⅝
$1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	118 122	5 14 9	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	100 102	5 17 2	March & September	...	...
			TELEPHONES.					
224,850	14/0	5%	Consolidated Telephone and Maintenance	1/16 1⅛	...	Yearly	...	...
220,000	£1	3%	Oriental (11s. paid)	7/16 7/16	3 15 11	...	...	...
*	*	...	National	5⅛ 6½	...	...	5⅛	5⅛
55,000	5	3/0	United River Plate	4⅜ 5¼	...	January and July	...	...
			ELECTRIC LIGHT.					
23,692	5	2/0	Anglo-American (fully paid)	...	...	February & August	...	...
79,234	5	6%	Swan United (£3. 10s. paid)	4⅜ 5⅛	4 0 0	...	5⅛	4 15/16
500,000	10	...	Metropolitan Electric Supply (£3 paid)	4⅜ 5¼	...	...	5⅛	4 15/16
			MISCELLANEOUS.					
87,350	12	12/0	Telegraph Construction and Maintenance	44 46	...	March and July	45⅞	45
41,600	10	10/0	India Rubber, Gutta Percha & Telegraph Works	18 19	5 5 3	February & August	18¼	...

JABLOCHKOFF'S

DISTRIBUTION PATENT

(Being a Patent for "Producing and Dividing Electric Light," No. 1996 of 1877.)

THE UNITED ELECTRICAL ENGINEERING COMPANY (LIMITE

Are Proprietors of the above Patent, and Warn the Public against Infringement.

The following are Licensees:—

Anglo-American Brush Electric Light Corporation, Limited.
Crompton & Co., Limited.
S. Z. de Ferranti.—London Electric Supply Corporation, Limited.
W. T. Goolden & Co.
Hammond & Co.
Wilson Hartnell.
Johnson & Phillips.
Laurence, Paris & Scott, Limited.
Malder Brothers & Co.
Paterson & Cooper.
Ernest Scott & Co.
Siemens Brothers & Co., Limited.
J. G. Statter & Co., Limited.

3, Prince's Mansions, Victoria Street, Westminster.

MANVILLE & MADGEN, *Managing E*

Digitized by Google

Digitized by Google

Digitized by Google

THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 607.—Vol. XXIV. FRIDAY, JANUARY 3, 1890. Price Fourpence.

NOTES.

We this week publish as a supplement a map showing the Metropolitan districts which have up to the present been allotted to various electric supply companies. The total area covered amounts roughly to about 15 square miles, and extends from Rotherhithe and Deptford on the East to Kensington on the West, and from Wandsworth on the South to Marylebone on the North. With the exception of the City, within which no company has as yet obtained statutory powers, the territory already allotted is the pick of the London district. Thus the ground covered by the Metropolitan Electric Supply Company comprises practically all the London theatres, the majority of the big hotels, the busy district of the Strand, and the wealthy residential district round Manchester-square. The area allotted to the London Electric Supply Corporation is largely composed of West End shops and private residences; while the smaller districts, worked, either separately or in competition with the London Company, by the St. James's Company, the Chelsea Company, the House-to-House Company, and others, are of a superior residential character.

The Metropolitan companies do not, however, intend to rest on their oars, and there are numerous applicants for the overgrown parishes of St. John, Hampstead, St. Pancras, and Paddington, while four companies are anxious to supply current within the City. Should all these applications be acceded to, practically the whole of the area included in our map will be adorned with the distinguishing colours of the various supply companies.

We are glad to learn that the question of "blocking Orders," to which we referred in our issue of December 20th, is occupying the attention of the Committee of the Electrical Section of the London Chamber of Commerce, who have addressed the following circular to the leading supply companies:—"The attention of the Electrical Section has been called to the fact that many of the notices which have been given by the local authorities of their intention to apply for Provisional Orders have been given with a view of blocking the extension of electric lighting, owing to gas interests or other causes. The matter will be brought forward at the next meeting (28th inst.), and it is hoped that you will communicate to Mr. Trotter, the Correspondent, any corroborative evidence of such action as you are able to give, together with as many details as possible."

It is to be hoped that sufficient information will be forthcoming to enable the Committee to judge of the reality of the danger to electric lighting from the obstructive tactics of many of the local authorities. Information on this subject, even from those who do not receive circulars, would, we are sure, be greatly valued by the Committee.

On Monday evening last a fire took place at 8, Grosvenor-square, the residence of Mr. W. A. T. Amherst, M.P., the newspaper report of the occurrence adding that the origin of the fire had still to be inquired into, but there was a theory that the cause was an overheated electric wire. In the same way that the Boston fire and the New York fatalities have recently been made convenient pegs upon which to hang sundry advertisements, the unfortunate episode in Grosvenor-square afforded Mr. Edward Palliser an excellent opportunity of injuring a trade rival. "I see," said Mr. Palliser, in a letter to *The Times* of Wednesday, "there has been an accident in Grosvenor-square, said to be due to the heating of an electric wire. If so, it *must have been a wire connected with a high-tension system*" (the italics are our own). Why the overheating of an electric wire must necessarily be caused by a high-tension current is not at first sight apparent. In the next sentence, however, we are informed that the St. James' and Pall Mall Company, which was inaugurated by Mr. Palliser, is now ready to supply the harmless low-tension current. Mr. Edison's alarmist contribution to the *North American Review* was, we suspect, mainly inspired by the hope of damaging a rival system, but the effective use which has been made of this article at Barnsley might, we think, have warned Mr. Palliser that these one-sided statements do harm to electric lighting generally.

For the probable origin of the fire we have only to peruse the following extract from a report made by Mr. Musgrave Heaphy, and published in a letter from Major Waller in yesterday's *Times*:—"The conductors were in contact under the floors, they were unencased and fastened by metal staples. Among the few places that I was able to examine I found that a staple had cut into the insulation. The conductors in another place were in contact with the bell wires." With wiring of this class a fire was only a matter of time, whether the house was connected to a high or a low-tension system, and it is satisfactory to learn that the London Electric Supply Corporation have for

Digitized by Google

some time past refused to supply current to houses in which the wiring is not according to their own specification.

NOTHING is more surprising in connection with the scare as to the dangers of electricity, which is now subsiding in the United States, than the fact that a whole series of alarming reports has come before us in rapid succession, although high-tension currents have been largely in use for several years, and have not latterly increased to any great extent even in the towns where the excitement has been greatest. No doubt the explanation of this is to be found in the heated state of the public mind, and in the skilful use made by opponents of electricity of any substratum of fact which they could discover here and there. We have already drawn attention to several instances—such as the Boston fire—where, on investigation, no proof has been forthcoming to connect electricity with the disasters laid to its door; and we now wish to utter a word of warning as to the cause of the gas explosions in the New York subways, which have, without hesitation, been put down to electricity. We think that the gas interests have, in any case, little cause for the self-congratulation with which, according to a New York correspondent, they appear to view these events; for, whatever the cause of these explosions may be, there can be no question that the gas would not be in the subway if the gas companies did their work properly and kept the gas where it ought to be—that is to say, in the gas mains. It seems indisputable that the leakage of gas from the mains is often very great, and so long as this is the case there must be danger.

IN London we have had at various times explosions very similar to those which have lately occurred in New York, and these have taken place under circumstances that rendered it impossible to attribute them to electricity. For instance, a very serious explosion in the Tottenham Court-road district some years ago—the most serious case that we remember—took place long before any electric light mains were even contemplated in that district. We recommend electrical engineers to consider this question seriously, for while it is quite possible that leakage from their conductors may cause explosions, it must not be lost sight of that coal gas has no right in their conduits, and that its presence, especially in wet or damp situations, is very deleterious to many otherwise good insulating materials, and may cause such injury that, beyond and quite apart from the risk of explosions, it will ultimately render necessary the replacement of cables which have, by its presence, become too seriously lowered in insulating qualities.

ALTHOUGH the figures given by Mr. CROSBY in his interesting article on "Practical Points in Electric Car Service," which we print in another column, are not entirely founded on ascertained fact, yet they form a sufficiently valuable contribution to the somewhat scanty literature on electric traction. Mr. CROSBY works out the average cost of electric traction per car mile on the four lines referred to by him at a little over 2½d. Another important relation which is brought out in this article, though it must be received with some reserve, since it is founded only on the data of two lines, is that on average roads only 44 per cent. of the 24-hour capacity of the generating station will be actually used on the cars. Mr. CROSBY's figures also show that on an average every E.H.P. hour in the station will produce one car mile of service on the line. It is certainly satisfactory to find that the experience on the four lines tested by Mr. CROSBY is that heavy gradients do not increase the average power required to the extent which might have been anticipated. The strain of gradients upon both generating and motor plant is, however, perhaps best shown by the maxima. Thus, at Richmond on a 9 per cent. gradient 25·6 horse power was the maximum required to start a load of 8,500lb., while at Cleveland on a very slight gradient only 15 horse-power was required for a much heavier load. Mr. CROSBY very aptly points out at the end of his article how greatly the coal bill may be modified by the handling of the variable resistance on the car—a fact which has not, we think, been sufficiently recognised up to the present.

THE wreck of the "Tenby Castle," off Holyhead, resulting in a loss of 11 lives, has again called attention to the question of electrical coast communication, the fatalities in this case, as in so many others, being due to the delay in apprising the nearest lifeboat station of the wreck until too late to save all the lives. A man on horseback had to be sent from the coastguard station, five miles distant, there being no telegraph line connecting the two points, although situated at a dangerous part of the coast. We are glad to notice that Mr. ROBERT BAYLY is again writing warmly on the subject in *The Times*.

THE Medical Battery Company have written to us with reference to our editorial note on 13th ult., stating that they said something different from what we alleged they had said. We do not dispute it; but, all the same, they also said what we ascribed to them, the words being copied from the advertisement columns of the *Standard*.

Telephonic Development in Germany.—Telephonic communication has lately been established between Berlin, Cottbus, Forst (Lausitz), Guben, Spremberg, and Gorlitz.

The "Electrical Review" of New York.—This journal has now taken offices here at Bridge House, 181, Queen Victoria-street, where all communications are to be addressed to Mr. Charles Ffrench.

Bremen.—The Electric Lighting Committee has decided that all mains must be laid underground, but that the roads are not to be disturbed. The conductors are all to be placed in pipes under the footpaths.

St. Margaret and St. John's Vestry.—At the last meeting of this vestry it was decided, by 12 votes to 4, to refuse permission to the National Telephone Company to lay down pipes to carry telephone wires.

The Institution of Civil Engineers.—This institution, which was founded on January 2, 1818, has now on its roll 1,673 members, 2,698 associate members, 19 honorary members, 436 associates, and 978 students—together 5,804, against 5,616 at the same date last year.

Digitized by Google

The Telephone in Japan.—The Mikado has had constructed, at the cost of the State, a line of telephone between Yokohama and Striznoka, a distance of about 100 miles. It is the first telephone applied to the public service in Japan, and has so far been completely successful.

"Le Progres Postal, Telegraphique et Telephonique."—This is a weekly journal, published in Paris, and the special feature of which will be the publication in it of all official documents relating to the telegraph and telephone service which are likely to be of interest to the French public.

Eisenach.—The Town Council of this town has agreed to the contract made with the Berliner Electricitatswerke for the electric lighting of Eisenach. The town is to get 2 per cent. of the profits and 10 per cent. reduction for public lights. The work must be completed within one year.

Telegraphic Communication with the French Colonies.—Among the resolutions passed at the recent French Colonial Congress were two in favour of cables being laid between Réunion and Madagascar, and from there to the coast of Africa, and between Australia and New Caledonia.

Altona.—The Altonaer Quai und Lagerhaus Gesellschaft invites tenders for the electric lighting of the Altonaer Elbquai by 42 arcs and 80 incandescents. Applications must be made before January 19, 1890, to the Society, from whom all necessary information may be obtained on payment of 15 marks.

The Rubber Monopoly in Brazil.—The news regarding the establishment of a rubber monopoly in Brazil has been confirmed in despatches received by rubber merchants both in London and in Paris. The merchants of France and the United States have already appealed to their Governments to protest.

Copper.—The stock of copper in and afloat for Europe, according to Messrs. H. Merton and Co.'s statistics, diminished by 1,137 tons last month. At the end of the year 1888 the supply was 104,105 tons, and it is now 98,847 tons, having been as high as 124,876 tons on March 31, 1889. At the end of 1887 the total was only 42,301 tons.

The "Centralblatt" and the "Elektrotechnische Zeitschrift."—The *Centralblatt für Elektrotechnik*, edited since 1879 in Munich, has been incorporated with the *Elektrotechnische Zeitschrift* of Berlin, and will appear under this latter title in Berlin, with Mr. Uppenborn as editor. The united journal will in future appear weekly instead of fortnightly, the price remaining unaltered.

Brighton.—At the last meeting of the Town Council a letter was read from the Board of Trade, enclosing the report of Major Cardew, on his recent inspection of the installation of the Brighton and Hove Electric Light Company. The communication stated that the Board proposed to act upon the report, and to insist that the Company shall reconstruct their circuits within three months, as several of the spans of their wires are reported to be dangerous.

St. Thomas, Charterhouse, Schools.—The Clothworkers' Company valuable scholarship of £130 and five years' free training at the City Guilds and Central Institution (Technical Institute), at South Kensington, awarded for proficiency in English, Elementary Mathematics, Drawing, Physics (including Chemistry and Mechanics), has been taken by Philip Sageman, aged 14 years. For several consecutive years this prize has been taken by a pupil of the above schools.

Kalender fur Elektrotechniker.—The 1890 edition of the German Munro and Jamieson, as it may well be termed, is as crowded with electro-technical information as ever, the pocket-book having this year attained the respectable size of 284 pages of small print. The section on tests extends over 50 pages, while that on dynamos, their construction and testing, covers 30 pages. Other sections are devoted to electric lighting, the electric transmission of power, telegraphy, telephony, and electro-chemistry.

St. Pancras.—At a special meeting of the St. Pancras Vestry on Wednesday afternoon, it was resolved by 38 votes to 16 to obtain plans, specifications, and tenders for the supply of electricity for the purposes of light and motive power for 10,000 incandescent lights of 16-candle power each, and 90 arc lights. It was also resolved to employ Prof. Robinson to prepare the necessary plans, &c., and to call in, if necessary, Dr. Hopkinson as consultant. Mr. T. B. Westacott stated that the estimated cost of the installation was £60,000.

The Electrical Standardising, Testing, and Training Institution.—From our advertising columns it will be seen that a new institution has been formed, with Mr. Robert Hammond for founder and Mr. Hugh E. Harrison as principal, for undertaking the work of standardising instruments, testing apparatus and plant, and training electrical engineers, having electrical and engineering laboratories, equipped with modern measuring instruments and testing apparatus. Further information can be obtained of Mr. P. A. Latham, at the offices of the Institution, 15, St. Helen's-place, London, E.C.

"Electrical Industries."—The first number of *Electrical Industries*, which is the latest addition to the American electrical press, is entirely devoted to articles of a practical character. A distinguishing feature of this journal are the four directories which it is proposed to publish, corrected up to date, with every issue. These directories comprise (i.) A Directory of Electrical Manufacturers, (ii.) A Directory of Electric Light Stations, (iii.) A Directory of Electric Railways, (iv.) A Directory of Electrical Associations. *Electrical Industries*, which is published at Chicago, will appear monthly.

Electric Shot-Hoists.—The electrical ammunition hoist of Lieut. Bradley A. Fiske, now in operation on board the U.S. man-of-war "Atlanta," is reported to be giving satisfaction. The apparatus is called into play on all general quarters' calls, and hoists projectiles weighing 250lb. from the bottom of the hatch to the gun deck in ten seconds. In no instance has the hoist been taken down or given the slightest trouble. A great many naval officers were opposed to the apparatus on its introduction, but now nothing but praise is heard of it. The hoist has been put aboard the flagship "Chicago," and will, it is anticipated, be supplied to all the new ships.

The Vienna-Budapest Trunk Wire.—The telephone line between Vienna and Budapest was opened on Saturday afternoon. The first trials were satisfactory. The sound is conveyed with remarkable distinctness, every syllable uttered being so clear that the speaker may be recognised by his voice. Three wires have been put up, and it was found that two conversations might take place at the same time, but that the simultaneous use of the third wire unfavourably affected the transmission of sound on the two others. The Austrian section of the line is run at some distance from the railway and telegraph wires, but the Hungarian portion of the line is laid along the railway.

Postal Telegraph Revenue.—The revenue returns for the quarter ended December 31, 1889, show an increase in the gross receipts from the telegraph service of £75,000, as compared with the corresponding quarter of 1888. On a comparison of the annual periods ending December, 1888, and December, 1889, the increase during the latter amounts to £215,000. Details for the four quarters of the two years are as follows :—

	Mar. 31.	June 30.	Sept. 30.	Dec. 31.	Total.
1889...	£520,000	£525,000	£620,000	£590,000	£2,255,000
1888...	480,000	480,000	565,000	515,000	2,040,000
Inc.	£40,000	£45,000	£55,000	£75,000	£215,000

Electrolytic Preparation of Zinc and Tin.—Mr. Burghardt has recently devised a method of preparing zinc or tin by electrolysing a solution of an alkaline zincate or stannate. Whichever material is dealt with, it is necessary to first remove, by roasting, any sulphur, antimony, or arsenic that may be contained in the mineral. Thus refined it is converted into oxide, in which state it readily dissolves in a bath of melted caustic potash. The above two operations can be combined by pouring into the alkaline bath the refined mineral in a finely powdered state and adding powdered charcoal. On cooling, the mixture is dissolved with boiling water, and the solution is submitted to electrolysis.

Photographing Falling Water.—According to the *British Journal of Photography*, Herr E. Cohen, of Amsterdam, has recently succeeded in obtaining some interesting photographs of falling streams of water. He employed a vessel from the bottom of which issued a column of water one centimetre thick. The apparatus was placed in a dark chamber and illu-

Digitized by Google

minated by sparks from a Rhumkorff coil in connection with a Leyden jar. The falling column of water had a velocity of 8·28 m. per second, while the period of illumination was reckoned by Cohen at about $\frac{1}{82800}$ of a second. The results turned out most successful—the elevations and depressions of the stream, as well as the separate drops, being clearly distinguishable.

Electric Signalling Apparatus on the Northern of France Railway.—On the Northern of France Railway a very efficient electric apparatus is in use as a connection with the distant signals and the locomotives. On the road there is arranged a plate of considerable size; this is coupled with the distant signal in such a way that it rises when the signal is at danger, and is depressed when the disc shows "line clear." Upon the engine is a large and stiff wire brush, which sweeps over the surface of the plate when the latter is raised. An electric circuit passes from the terminal of a battery to the plate, thence through the brush to signalling apparatus on the engine, and from that to earth through the rails. The brush is not a delicate piece of apparatus, but a solid construction capable of sweeping snow off the plate, and of scraping its way through a coat of ice. The whole appliance is said to give very satisfactory results.

Wind Motors for Electrical Purposes.—The use of wind power for producing the electric light possesses the recommendation that it is cheap. A wind motor has been in successful operation for some time at the northernmost lighthouse at Cape de la Hague, where it drives two dynamos supplying accumulators. The windmill rests upon a timber framing, and transmits motion by means of a vertical shaft and two pairs of conical cog-wheels to a horizontal shaft. Pulleys are fixed to the latter, which drive the dynamos by means of belting. The windmill works automatically both during light winds and gales. This point has been obtained by employing a spherical regulator which acts by friction upon a shaft closing and opening the apertures in the wind wheel in such a manner that the surface exposed to the wind, according to its force, is enlarged or reduced. The dynamos are thrown in and out of gear automatically.

Transmission Plant at the Chevrant Paper Mills.—For the last three months the Chevrant Paper Mills at Domène (Isère) have possessed an electric power installation erected by M. Hillairet. The generator and receiver are over three miles apart. The 300 horse-power generator is driven direct by a turbine running at 240 revolutions. The water is conducted to the turbine in an iron pipe half a mile long, the head of water being equal to 230 feet. The receiver at the mills runs at 300 revolutions, and is capable of working up to 200 horse-power. The line is run overhead, and consists of a bare copper wire of 50 sq. mm. cross-section. The plant works day and night, and is only stopped twice within the 24 hours, for 20 minutes at a time. The average E.M.F. of the generator is 2,850 volts, and the average current is 70 amperes. The electrical efficiency of the installation is 83 per cent., the commercial efficiency, which has been very carefully determined, varies between 63 per cent. and 66 per cent.

The Paris Telephones.—M. Coulon recently appeared before the Budget Committee of the Chamber of Deputies and made a detailed statement with regard to the working of the telephone system by the State. Referring to Paris, M. Coulon stated that at present 7,000 subscribers were served by 12 exchanges, and the multiplicity of exchanges naturally resulted in considerable delay in making connections. The Paris staff was moreover insufficient and ill-disciplined, and the material handed over to the State by the Société Générale des Téléphones was worn out. M. Coulon asked for the sum of 500,000fr. in order to remedy urgent defects without delay. He proposes ultimately to reorganise and improve the entire system, by concentrating all the wires in one central exchange, by extending the telephone to the suburbs, and by erecting a trunk line between London and Paris. The necessary money will be obtained by deducting 1,000,000fr. from the 2½ millions annual profit at present made by the State. M. Coulon estimates that in ten years time the gross receipts from the telephone service will amount to 15,000,000fr., the net profits being at least 7½ millions. M. Coulon also reported that the number of new subscribers to the telephone system, which had fallen to 40 per month at the date of the transfer to the State, was 280 for October, 250 for November, and 180 for the first fortnight of December.

Electric Snow-Sweepers.—The following are some particulars of the electric snow-sweepers constructed for the West End Street Railway of Boston, and which recently proved so successful in operation. The car platform, which is framed of heavy oak timbers, is raised nearly 4ft. above the track and is about 6ft. wide by 20ft. long. This is supported by special heavy castings above a truck whose wheel base is 5ft. Upon the truck are mounted two 15 horse-power Thomson-Houston railway motors, one being geared to each axle exactly as in the ordinary mounting on a street car. These serve to propel the car only. The track brooms, which are cylindrical in shape, about 6ft. long and 30in. in diameter, are two in number and are mounted under the platform one at each end outside the truck, so that, in whichever direction the car is propelled, one broom will be in advance of the truck. The frame holding the broom is easily manipulated by levers upon the car platform. Upon the platform and about midway between its ends is mounted one 15 horse-power railway motor for driving the brooms. By means of a counter shaft and suitable clutches this motor may be made to drive either broom separately or both simultaneously, power being transmitted from the motor to the broom through a sprocket wheel and chain. The axis of the broom in changing from its highest to its lowest position is maintained at a constant distance from the counter shaft, thus retaining a constant amount of tension on the sprocket chain. Current is taken from the overhead wire by a trolley suitably mounted at the centre of the car. The whole of the machinery is enclosed, as far as possible, in snow tight, substantial cases, the platform machinery being especially well protected from possible injury by flying snow.

Electrical Activity in Canada.—Considerable energy is at present being shown in pushing electric lighting work in Canada. During the last year or two there has been a great development of electrical manufacturing in the Dominion, and as the demand is very brisk for apparatus, there is no reason to question the profitableness of these undertakings. One of the largest factories of the kind in Canada is that of the Royal Electric Company at Montreal, who bought the patent rights for Canada of the Thomson-Houston system, and who since 1884 have done a very large business. They have manufactured lamps and dynamos to the extent of about 7,000 arc-lamp capacity, and have plants running in Montreal, Ottawa, Quebec, Hamilton, London, Halifax, St. John, Charlottetown, St. Catharines, and many other places. In Montreal alone, where they began with 17 arc lamps in 1884, they now have 1,600 arc lights and 2,000 incandescents. The Edison Company have been at work for some time in Canada, and now have a large number of plants. Recently they reorganised their manufacturing business there, and now have matters on a good basis, being able to turn out a large quantity of material for which there is a steady sale. The Westinghouse Company have lately made a bid for Canadian business, and have already a large number of plants under way and in course of construction. The Western Electric Company have also sold plants in Canada; and a large number of small plants have been sold by the Ball and Reliance Companies. The Lahmeyer system also has its representatives in the Dominion, and the Brush Company have been at work there for some time, and have done remarkably well. One of the reasons for this electric lighting development is the number and availability of the water powers. A scheme which has just been put forward, and in which a large number of American capitalists of the North-West are actively interested, is the development of a grand water power at Port Arthur, in Ontario. Near that place is a river 350ft. wide, with a fall of 100ft., and it is proposed to build up a great manufacturing centre, such as Minneapolis, around these falls. Part of the power obtained is to be employed in a long-distance distribution of power electrically, and will be carried to a number of mines in the neighbourhood.

Digitized by Google

MAGNETISM IN IRON AND OTHER METALS.*

BY PROF. J. A. EWING, F.R.S.

II.

(*Continued from page 162.*)

§ 6. **Intensity of Magnetisation.**—We have seen that the magnetism of a magnetised bar may be described by reference to its ends, where the imaginary positive and negative magnetic substance is accumulated, the middle parts being inactive. From another point of view the magnetisation extends throughout the whole substance. We may think of every portion of the magnet as *polarised;* that is to say, every particle or elementary piece of the bar may be regarded as a separate magnet. Throughout the middle portion of the length these elementary pieces are grouped so that each pole of one touches the opposite pole of its next neighbour, and the result is that the middle portion of the bar shows no positive or negative magnetism; but at the ends the poles of the elementary pieces are no longer neutralised, and the poles of the pieces there become the poles of the bar. This is the modern view of the matter, and is in many ways an advance on the simple polar view. It is borne out by the fact, experimentally observed, that when a magnet is cut up into pieces, however small, each piece is a separate magnet.

§ 7. From this point of view we are to regard the magnetic state as existing continuously throughout the bar. If this state is uniform from end to end of a bar, the metal is said to be *uniformly magnetised.* If we could cut up such a bar by cross-sections into short lengths without disturbing the uniformity of the magnetisation, we should find every part to be a magnet with the same pole-strength as the original bar. If we could split it by longitudinal sections we should find the pole-strength of each part to be proportional to the area of cross-section in that part. In other words, if we could cut up the bar in any manner (always without altering the magnetic state of the metal) we should find that the pieces were separate magnets of which the moments were proportional to the volumes of the pieces. The magnetic moment of each piece will be the same fraction of the magnetic moment of the uncut bar that the volume of the piece is of the volume of the uncut bar. The magnetic state which existed throughout the bar before it was cut, and exists throughout each piece after cutting, may be specified if we state the *moment per cubic centimetre* of the metal. This quantity is called the *intensity of magnetisation*, and is usually denoted by I.

§ 8. **Relation of I to Pole-strength.**—Let M be the moment of a uniformly magnetised straight bar; let l be the length of the bar in centimetres, s its area of cross-section in square centimetres, and m its pole-strength.

Then $$M = m\,l.$$

The volume of the bar is $s\,l$; hence I, which is M divided by the volume, is $\frac{m\,l}{s\,l}$, or $\frac{m}{s}$.

We might, therefore, have defined I as the *pole-strength per square centimetre of sectional area.* It is useful to remember that I has also this meaning, but the essential idea implied in the phrase "intensity of magnetisation" is better conveyed by the definition of I given above. We are to think of I as the measure of a polarised state which has a true existence everywhere in the substance of the metal, though it manifests itself only at the ends, so far as external action is concerned.

§ 9. **Ring Magnet.**—The usefulness of this idea will be at once apparent if we consider what happens when a uniformly magnetised rod is bent round into a ring until the ends meet. There are now no poles: those that existed in the rod have met and have neutralised each other; there is now no magnetic moment, and the ideas of poles and moment will no longer serve as means of stating the magnetic state of the ring. But the ring is still magnetised: if we were to cut it in pieces we should find the pieces to be magnets. The magnetic state expressed by the quantity I still exists within the metal: there is a definite "intensity of magnetisation" throughout. If we were to cut a narrow gap through the ring we should find on one side of the gap a positive pole, and on the other side a negative pole, the strength of which would be $I\,s$.

§ 10. **Lines of Magnetisation.**—Suppose such a gap or crevasse to be cut, the number of lines of force which cross the gap is $4\pi I\,s$ (by § 4), and hence the magnetic force within the gap (which is the number of lines of force per square centimetre) is $4\pi I$; so far, that is to say, as the magnetic force there is due to the magnetism of the ring. Of course there may be additional magnetic force within the gap due to other magnets or to electric currents in the neighbourhood; but for the present we may confine our attention to the force that exists there on account of the magnetisation of the ring itself alone. The same lines $4\pi I\,s$ which cross the gap may be conceived as extending continuously round the ring through the substance of the metal. Each line forms a closed curve: a short part of it is in the gap, the greater part is in the metal. We may call the parts of the lines which lie within the metal *lines of magnetisation.* The name "lines of force," which is applicable to the lines in the gap, is inappropriate to those parts of the lines which lie within the metal, because the lines within the metal do not form a measure of the magnetic force there.

§ 11. **Lines of Magnetisation** (*continued*).—Fig. 4 illustrates the supposed case of a narrow gap or crevasse, A B, cut across the substance of a magnetised ring at any place in its circumference.

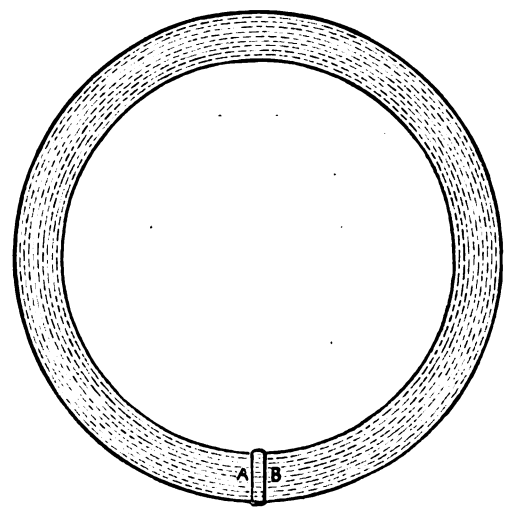


FIG. 4.

Within the metal we have the lines of magnetisation which are shown by dotted lines in the figure. The number of these, per square centimetre of cross-section, is $4\pi I$. These lines are continuous closed curves, and pass across the gap, forming lines of force there, which are shown by full lines in the figure. If we measure the magnetic force within the crevasse, we shall find it equal to this quantity, $4\pi I$, together with whatever other magnetic force may act there in consequence of electric currents or magnets in the neighbourhood. That part of the magnetic force within the crevasse which is represented by $4\pi I$, is directly due to the breach which we have made in the continuity of the magnetised ring. It may be regarded as existing there in consequence of the fact that lines of magnetisation within the metal are necessarily continuous with lines of force outside the metal.

Take another way of looking at the matter. We may think of this force within the crevasse A B as due to free magnetism on the surfaces A and B. When we cut the crevasse in the magnetised ring, we bring into existence a positive pole which is distributed over the surface at A, and a negative pole which is distributed over the surface at B. The strength of each of these poles is $I\,s$, and the surface-density of free magnetism—that is to say, the amount of free magnetism per square centimetre of surface—is I. By a well-known proposition in the theory of attraction, a plate on which the surface-density is I

* All rights are reserved.

Digitized by Google

attracts a unit particle placed close to it with a force equal to $2\pi I$ (except near the edge, where the force is less). Let a unit positive magnetic pole, then, be placed in the crevasse. The plate of free magnetism on A repels it with the force $2\pi I$; the plate of free magnetism on B attracts it with an equal force. The whole force at a point in the crevasse, due to the magnetisation of the ring, is the joint force exerted by the two plates; in other words, it is $4\pi I$.

Suppose now that the uniformly magnetised magnetic ring is stretched out to form a straight bar. If we imagine a crevasse to be cut across it at any part of its length, we shall still find in the crevasse the lines $4\pi I$ per square centimetre due to the continuous magnetisation of the bar, in addition to whatever lines of force may exist there in consequence of electric circuits or free magnetism in the neighbourhood (excluding, of course, the free magnetism on the faces of the crevasse, to which the lines $4\pi I$ are directly due). The whole field within the imaginary crevasse may therefore be thought of as made up of two components, namely, (1) the lines of magnetisation, the number of which is $4\pi I$ per square centimetre; and (2) the magnetic force due to external causes, namely, that which is due to electric currents and free magnetism in the neighbourhood. Amongst the causes of this magnetic force is to be included the free magnetism at the ends of the bar itself, as well as the poles of any other magnets which may be near enough to produce any sensible effect.

(To be continued.)

THE MANWAREN ELECTRIC METER.

We illustrate below a recent type of meter which has just been brought out by Mr. Albert H. Manwaren, of Philadelphia. This meter consists essentially of a multipolar magnet, a number of armatures, and a registering device, the action of which is controlled by the position of the armatures. In addition there is an electrically-operated winding device for the registering mechanism. We take our account from the *Electrical World* of New York.

Referring to Fig. 1, A is a multipolar magnet operating a series of armatures supported by the outside row of posts, and the inner ends free to move in the vertical slots of the central ring. The inner posts or cores are provided with a screw or thread for adjustment, which is made by graduating the distance of the cores from the armatures according to the quantity of current traversing the coils. Suppose, for instance, that the adjustment is made for lamps of 8 candle-power, then the current of one 8 candle-power lamp will raise the first armature, and by adding one more lamp of the same power the second armature is raised, and so on up to the capacity of the meter. Now, if one lamp of 8 candle-power and one of 16 candle-power be used, three armatures will be attracted; and if one lamp of 32 candle-power be added four more armatures will be raised, making seven armatures raised in the path of the registering trip, which registers the same as if seven lamps of 8 candle-power were burning. In Fig. 1 also the clockwork is shown having a hollow shaft supporting an arm at the lower end carrying the registering trip, which is rotated by the clockwork. The trip passing in under the end of the armatures that are up in its path, is depressed at the outer end, and the inner end raises the rod, which is free to move in the hollow shaft. The rod is connected to the movable plate supporting two pawls (push and pull), which is raised one tooth of the gear wheel and allowed to drop of its own weight as soon as the trip has passed the armature acted upon. The trip or lever is rotated by the clockwork once around in six minutes, thus making a new register of the exact number of lamps burning every six minutes. Each indication of the hand or pointer is equal to one lamp of 8 candle-power burning six minutes, or whatever candle-power is used for a standard and the meter is adjusted to. On one end of the rotating arm is a treadwheel, used to force all the armatures down in advance of the trip, and only those adjusted to the quantity of current flowing through the coils are attracted again.

In Fig. 1 H represents an end view of the automatic winding device, better shown in Fig. 2. This is a very simple arrangement, composed of two solenoid magnets, with one-half the core of each made of non-magnetic material. The yoke is used to support the rack, which is geared to the winding shaft of the clock. When the circuit is closed by means of the contact rod, the cores are drawn into the magnets, and in so doing the rack bar

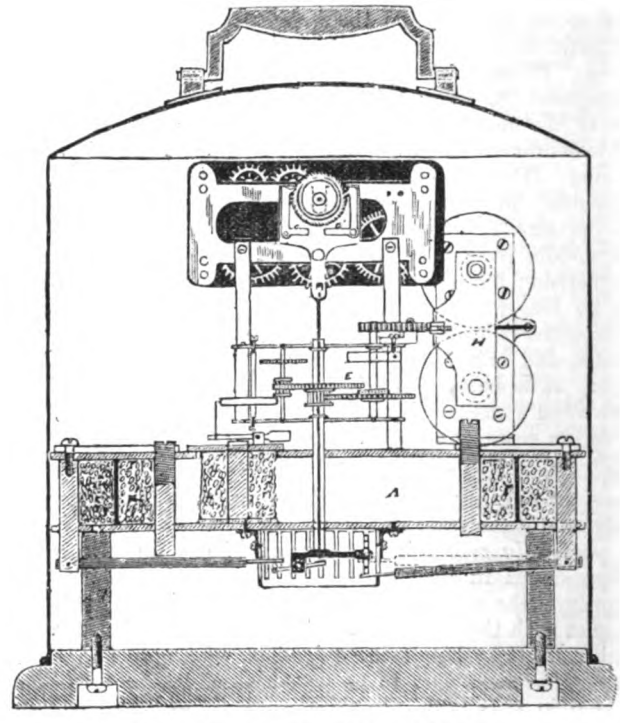


Fig. 1.—Section of the Manwaren Meter.

acts on the gearing and winds the spring. When the core has moved its full length a stud on the yoke pushes the contact rod away from the contact plates and opens the circuit. The spring now operates on the clock mechanism, and the rack bar is

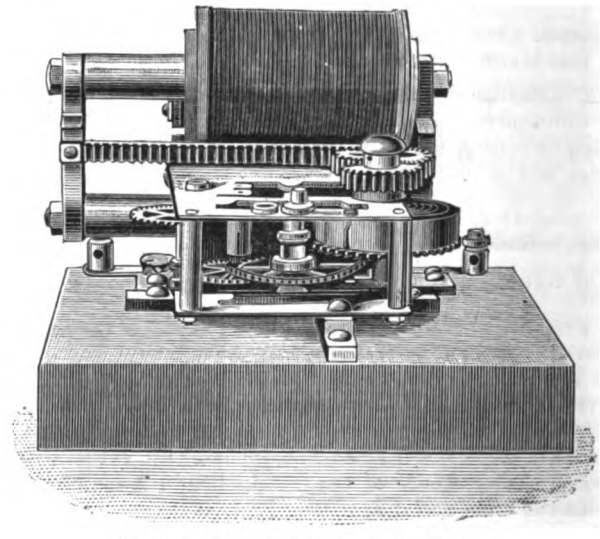


Fig. 2.—Manwaren Meter, winding device.

slowly moved to the length of its travel. At this point a stud, projecting from the rear end of the yoke, moves the rod in contact with the plates, closing the circuit, and causing a prompt back movement to wind the spring as before; this occurs every 20 minutes, and is entirely automatic in its action.

The arrangement for stopping the clock when there is no current being used is shown in Fig. 1. It consists simply of a small magnet connected in series in the lighting circuit, operating an armature which acts upon the balance-wheel; the

Digitized by Google

clock is started automatically by the movement of the armature when it is attracted again.

The meter is small (*see* Fig. 3) and is not limited in construction to any particular number of lights. A 25-light meter is 7in. in diameter and 8in. high, weighing 10lb.; a 100-light meter is 12in. in diameter and 10in. high; while a 200-light meter is the same diameter and 2in. higher. The large meters are constructed with several compound magnets, each having a set of armatures and a trip with one magnet placed above the other and one clockwork with the hollow shaft extending through all the different coils; this revolves all the different trips, which are set one rotation in advance of the other, so that only one trip is registering at a time. By this method a

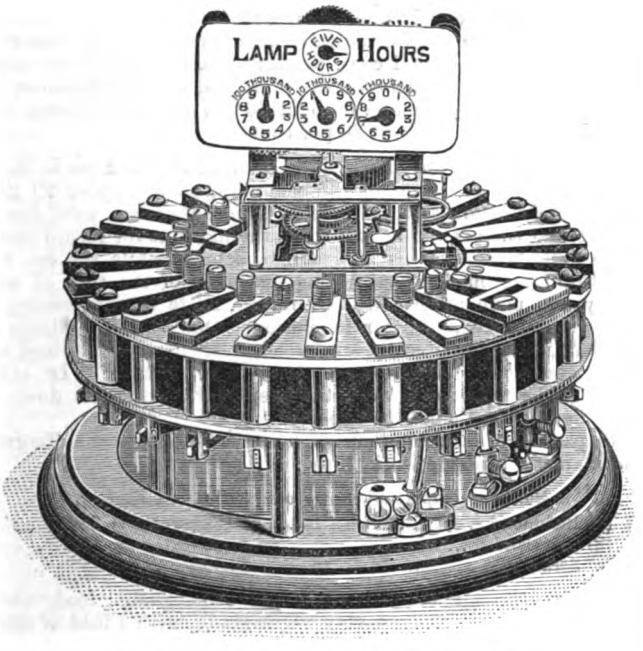


FIG. 3.—Manwaren Meter with case removed.

500-light meter composed of five 100-light coils placed one above the other, as mentioned above, is 12in. in diameter and 15in. high, making it convenient for transportation and requiring but a small space.

PRACTICAL POINTS IN ELECTRIC CAR SERVICE.*

BY O. T. CROSBY.

The following statement of facts results from observations made by Messrs. J. H. Vail, C. L. Edgar, Wm. Habirshaw, and myself, in the month of May, 1889. The number of individual readings taken was too great to permit repetition here. The system of observation was this:—Volt and ampere readings were taken at 30-second intervals, the instruments being placed on a car in each of the three cities—Richmond, Va.; Cleveland, O.; and Scranton, Pa. Notes as to passengers carried, stops made, &c., were taken on the car. Averages for long periods were taken from records kindly furnished by the railway companies in Richmond and Cleveland. On the three lines, which were carefully examined, the motors used were those of the Sprague Company's first type, save in the case of one car in Cleveland, which was run by motors of the Sprague Company's second type. The dynamos were of the Edison type. We obtained much interesting information by inquiring at the central station of the Eckington and Soldiers' Home Railway, Washington, D. C. This road has motors and dynamos of the Thomson-Houston Company. The facts given concerning this road are to be understood as not authenticated by instrumental checking. While the observations from which conclusions will be here drawn are now, perhaps, the most detailed and extensive of their kind, I hope many such will soon be on record, giving final values to certain important constants. More nearly than anything else, I believe that the car-mile is the unit of earning capacity, a certain population per mile being assumed. Hence the prominence of that unit below. The unit car may be taken as the regular 16ft. car. In Washington double-deckers constitute part of the equipment and appear very attractive.

* From the *Electrical World* of New York.

Coal Consumption.—We yet lack any accurate scale showing values of different coals as heat producers. Taking things as we found them:—

In Washington, soft coal cost per ton	$2.90
In Richmond „ „ „	3.00
In Cleveland „ „ „ (slack).....	1.25
In Scranton, culm coal (from adjacent pile), cost per ton ...	0.10

The coal consumption per car mile in these cities was as follows:—

In Washington, coal in lbs. per car mile ..... $\frac{2,800}{550} = 5{\cdot}0$lbs.

In Richmondco, mplicated by supply of light and power from same boilers.

In Cleveland, coal in lbs. per car mile ..... $\frac{10,000}{1,270} = 8{\cdot}0$ „

In Scranton, coal in lbs. per car mile..... $\frac{7,000}{1,200} = 5{\cdot}6$ „

The car-mileage per day of entire service in Washington, cannot be considered accurate; it was made up from the "say-so" of station *employés*, not referring to written records. Its error is probably not greater than 10 per cent.

Cost of Coal per Car Mile.

In Washington..... $\frac{2{\cdot}90 \times 5}{2,000} = 0{\cdot}72$ cent.

„ Cleveland..... $\frac{1{\cdot}25 \times 8}{2,000} = 0{\cdot}50$ „

„ Scratton ..... $\frac{0{\cdot}10 \times 5{\cdot}6}{2,000} = 0{\cdot}028$ „

Attendance.—In this I include only the attendance necessary for producing and delivering power, and nothing for conductors and drivers. Engineers, firemen, motor cleaners, linemen, and a part of general superintendence constitute this item.

Cost per Car Mile.

In Washington	2·5 cents.
„ Richmond, complicated as above.	
„ Cleveland	2·0 „
„ Scranton	2·0 „

Oil, Waste, Water, &c.—No great error will be made in putting this at 0·2 cent per mile at all points.

Interest, Insurance, Depreciation, and Taxes on Real Estate per Car Mile.—The value of real estate in the plants visited was not readily attainable. It was in no case used to its maximum capacity, and values per horse-power of total capacity varied very much. So, also, as to tax rate. The figures I will use must be understood as not founded on authentic data, but on fair approximation. The value of real estate for plant making 1,000 car miles per day is taken at $15,000; interest at 5 per cent.; depreciation at 2 per cent.; insurance and taxes at 2 per cent.; total, 9 per cent.

Applying this to $15,000 and dividing by $365 \times 1,000$, we obtain 0·37 cent per car mile.

Machinery and Line.—The cost of maintenance of the electrical machinery of a street railway has been the subject of much inquiry. The "extreme youth" of the art offers sufficient explanation of the vagaries shown by this element of cost. It has sometimes been riotous, like a boy out of school; sometimes quiet, like a boy after a flogging. At this date, maintenance on any road installed by one of the few well-known companies in the business will show a much more modest front than it did even six months ago. If we should take periods of six months on the roads in question they would, doubtless, all show great fluctuations in the depreciation figure. When, therefore, I take 5 per cent. per year on the whole electrical equipment, dynamos, motors, and line, I am giving expression to an opinion founded on many and varied happenings constituting quite a thorough practical experience in the work. Further, I must say that we will understand depreciation values one year from to-day much better than we do now. My 5 per cent. is "subject to change without notice," though guaranties very near this figure can now be had from reliable companies. Include in the plant on which 5 per cent. maintenance is to be calculated, the boilers and engines, and this percentage becomes still safer. It may be remembered that dynamo maintenance is known to be less than 5 per cent.; line maintenance by care can be kept inside that figure; hence, even if motor maintenance exceed that 5 per cent. our average remains nearly correct.

The total cost of steam and electric machinery and line equipment sufficient to perform a service of 1,000 car miles per day is an element as variable as the cost of real estate. As yet, also, we often find a capacity in excess of actual service. The use of iron

Digitized by Google

poles, instead of wood, will add from $800 to $1,600 to the cost of each mile of road.

In the systems here treated, the numbers of car miles per day made on each mile of line work are pretty closely as follows :—

Washington ...	200
Richmond	140
Cleveland (all double track)	400
Scranton	130

Differences in the proportions of single and double track and actual traffic demands largely affect such figures. The cost per mile of overhead work for various sets of conditions is now quite regular; but variation in the condition is considerable. Thus, nature of soil, kind of pavement, kind of rail, distance from station, number and size of cars per mile, grades, volume of traffic, number of trees on line, kind of pole, general finish of line, local price of labour, freight charges—all these enter. Again, I will here use probable values rather than actual costs of the above lines, on one of which especially a considerable expenditure was made for that valuable but intangible commodity—experience. I will, therefore, assume :

Average cost per mile of Richmond and Scranton type (wooden poles, lines principally single track)	$1,500
Average cost per mile, Cleveland type (double track, iron poles)	3,500
Average cost per mile, Washington type (centre pole of iron, principally double track)	2,700

These investments may be considered as sufficient to support more than the car mileages above given, but average traffic may not demand more. The investment for motors per car mile is now generally larger than it need be if traffic were everywhere heavy enough to demand double-car service (one motor car, one tow car). The equipment is frequently sufficiently powerful to do towing service when no such service is required. This figure also varies, in case of single car service, with what the owners choose to get out of their plant. Thus, in the points visited, average car miles per day for each motor car in service were :

In Cleveland, regular car mileage	90	miles per day.
„ Washington (approximate)	80	„ „
„ Richmond	60	„ „
„ Scranton	80	„ „
„ Cleveland	80	„ „

Since the date of inspection, the car mileage per day per car has increased greatly in Cleveland, and, I think, in Washington also.

The cost of motor equipments per car may now be taken at about $2,500. The dynamo capacity required to drive each car will generally be found to be from 7·5 to 10 horse-power. When the number of cars is considerable, the lower figure will apply to even the hours of heaviest traffic, but the desire to have a margin on dynamo capacity, thus permitting some increase in number of cars without increase of station plant, usually operates to give the larger figure, and often a higher one still. Actual readings, extending over long periods, showed a maximum of 7·5 horse-power per car, called for in Cleveland and Richmond, from 16 to 20 cars being on the line. The "say-so" of station *employés* in Washington and Scranton indicated about the same figure.

We may, therefore, assume 10 horse-power of dynamo capacity as installed for each car on the line. Save in very small units, the cost, covering spare parts and all station equipment, may be taken at $45 per horse-power.

The cost of engines and boilers is very near the same figure per horse-power, and we may assume 11 horse-power installed for every car in service. We may now sum up as to machinery and line work. Interest will be taken as before at 5 per cent. ; maintenance, as explained, at 5 per cent. ; taxes and insurance at 2 per cent. ; total, 12 per cent.

Then the cost per car mile =

$$\frac{\text{Cost one mile of line} \times 0{\cdot}12}{365 \times \text{car miles per mile}}, \text{ plus}$$

$$\frac{\text{Cost one car equipment} \times 0{\cdot}12}{365 \times \text{daily mileage per car}}, \text{ plus}$$

$$\frac{\text{Cost 10 H.p. dynamo} \times 0{\cdot}12}{365 \times \text{daily mileage per car}}, \text{ plus}$$

$$\frac{\text{Cost 11 H.p. steam plant} \times 0{\cdot}12}{365 \times \text{daily mileage per car}}$$

Applying the figures above given, we have for—

(1)	Washington, per car mile	1·8	cents.
(2)	Richmond „ „	2·20	„
(3)	Cleveland „ „	1·60	„
(4)	Scranton „ „	1·80	„
	Total	7·40	cents.
	Average	1·85	cents.

In (3), above, the large number of car miles per mile of line, and good figure for car mileage per car, bring the total down, in spite of an expensive line. Bringing all the items of cost per car mile together, we have, for motive power :

	Coal.	Attendance.	Real estate.	Machinery and line.	Oil and waste.	Total.
Washington ...	0·72	2·5	0·33	1·8	0·2	5·55
Richmond	0·72 (?)	2·5 (?)	0·33	2·25	0·2	6·00
Cleveland	0·50	2·0	0·33	1·68	0·2	4·71
Scranton	0·028	2·0	0·33	1·83	0·2	4·18
Average	...	...	...	...	...	5·09

The figures for Richmond marked (?) were not attainable. Coal and labour being of nearly the same values as in Washington, equality in these items has been assumed.

Interest on investment constitutes about one-fourth to one-fifth of the whole, *i.e.*, about 1 cent. per car mile, or, say, 20 per cent. of the total. Coal (except in the abnormal case of Scranton) is about 12 per cent., attendance about 40 per cent., machinery and line (without interest) about 20 per cent.

Effect of Grade.—Out of a total of 120 readings on a car in Richmond, going over a line of heavy grades, there appear 29 zero readings for current, and of these not more than six were due to the fact that the car was at rest when the moment for record came. Let us take, however, only 20 readings as made while the car was in motion ; that means, that during one-sixth of the time of run, gravity and momentum effects combined, made it unnecessary to use current to keep the car in motion. Out of 120 readings in Cleveland, over a practically level road, only 15 zero readings are found, and nearly all these were noted as "stops." In other words, grades work both ways, and keep average currents down to better figures than might be expected.

Comparison of maximum efforts, however, indicates the disagreeable character of grade work, thus :

Maximum supply of energy observed at one reading.

(1) Richmond	19,225	watts =	25·6 H.p.
(2) Cleveland	11,500	„ =	15·0 „
(3) Scranton	14,400	„ =	19·2 „

Reading (1), was taken on a 9 per cent. grade ; load, about 8,500lbs. ; reading (2), on a very slight grade, with a load of about 9,800lbs. ; reading (3), on about a 7 per cent. grade, load about 8,800lbs. On other occasions in Richmond I have seen, with extravagant loads, readings nearly 50 per cent. greater than the 25·6 above.

An important relation to be observed, as facilitating calculations, is the relation between car mile and horse-power hour. This relation was found to be :

From special test in Richmond	1	car mile =	1·01 H.p.
„ „ Cleveland	1	„ =	0·67 „
„ „ Scranton	1	„ =	0·94 „
From averages of several days in Richmond	1	„ =	1·18 „
„ „ „ Cleveland	1	„ =	0·90 „
Average			·94 H.p.

The loads in the special tests were ordinarily from four passengers to 24. In these figures the beneficial effect of small grades is seen. It is probable that the average number of passengers carried per car mile is in Cleveland (type of light grades) greater than in Scranton or Richmond (type of heavy grades), otherwise the difference would be greater between the heavy grade and the light grade roads.

It is to be noted that the horse-power here considered is that delivered to the cars. To learn what the same relation is when carried to the power house, we must next learn of the line efficiency. Taking figures of special tests, this is as follows :

In Richmond	88	per cent. (1)
„ Cleveland	94·4	„ (2)
„ Scranton	88	„ (3)

These percentages will not, of course, be maintained at hours of heaviest traffic. In (1) and (3) a number of track connections were broken, causing considerably more than necessary loss with the copper actually on the line. Whatever the loss may be in these three roads, we all know that the loss may be made what we please. Let us take it at 10 per cent. It may then be said, closely enough for anything less than very accurate calculations, that on average roads one electrical horse-power hour in the station will produce one car mile of service on the line.

Nearly the same value for this relation may be deduced from figures published by Dr. Louis Bell, taken from practice of the Lafayette, Ind., electric railway (*The Electrician*, July 5 and 12, 1889). He says that 16·1lb. of coal were required to produce one electrical horse-power hour. He says that six cars are in use,

Digitized by Google

making from 35 to 40 miles per day. We may assume then about 230 car miles per day.

Total coal consumption for the day was given as 4,500lb.;

$$\frac{4500}{230} = 19{\cdot}5.$$

Hence, one car mile $= \frac{19{\cdot}5}{16{\cdot}1}$, or 1·22 electrical horse-power hours.

The figure for coal is very high as compared with practice in a great majority of electrical stations, for either light or power. Coal per indicated horse-power hour is given by Dr. Bell as 7·3. This is high enough, but the jump to 16lb. per electrical horse-power hour shows poor steam and shafting service, or error in calculation. Another relation calculated, that between maximum two-hour supply of energy and average supply of energy, may become of importance, especially in the case of purchase of power by meter, the seller wanting to know beforehand how much current he can *sell* from a certain plant for car service. The plant must have *normal* capacity to supply the maximum effort continuing for a reasonable time, say one hour, while it may be relied on to "spurt" for an extravagant, but very short demand.

I found that in Richmond, with about 21 cars out, readings, extending through several days, showed a current of 220 amperes as flowing continuously for one hour, while the average of same readings, reduced to 24 hours per day, equalled 110 amperes, or 50 per cent. of the one-hour maximum. In Cleveland, corresponding figures were respectively 173 amperes and 66 amperes, *i.e.*, 38·3 per cent.; 16 cars being in service. Taking the mean of 50 and 38, that is 44, we may say that, on average roads, only 44 per cent. of the 24-hour capacity of the central station plant will actually be used on the cars, the plant being such as can easily handle maximum loads of one hour duration.

Miscellaneous Facts.—In Cleveland schedule speed is nine miles per hour. We made ten miles an hour on the observation trips, including stops for a number of passengers, the length of route being 3·3 miles. In Scranton and Richmond schedule time is about six miles per hour.

Special tests limited to the exact time of a run, and made by daylight, do not measure all the power really consumed in car service. Lights at the station and on the cars, field circuits of shunt dynamos, movements of cars in yards, leakage and drop on the line; all these make their demand on the engines. Most of these additions are independent of grade; hence, as shown above, average car mileage per horse-power hour in the station, and from bus-line ammeter readings, will be found more uniform, as between different roads, than the trip determinations on the cars. Thus, from

Special Tests.

	Horse-power Hours per Car Mile
Cleveland	·67
Richmond	1·05 = 50 per cent. greater than ·67
Scranton	0·94 = 42 per cent. greater than ·67

From Station Readings.

Cleveland	0·9
Richmond	1·18 = 31 per cent. greater than 0·9

The average expenditure of energy on cars, as shown in the special tests was:

	Watts.	H.P.	Average Load.	Total Rise.	Average Speed.
Richmond	4,833	6·5	8,500	55 feet.	6, one way
Cleveland	4,986	6·6	9,500	0 „	9, round trip
Scranton	5,587	7·4	9,500	100 (?) „	5·7, one way
„	3,400	4·5	8,200	100 (?) „	6·0, one way
„	4,494	6·0	8,800	0 „	5·85, round trip

Starting currents were generally 18 to 20 amperes, with about 460 volts at car. On grades, starting currents were 25 amperes. The voltage at certain points was found as low as 325, due to bad ground connection, station voltage being about 475. At many points on the lines in Cleveland and Scranton 500 volts were recorded, voltage at stations being 505 to 525.

It is to be remembered that in all individual tests, equipped with moters of any kind now used, the handling of the variable resistance, whether internal, as in the commutated field of the Sprague Company's motor, or external, as in the Thomson-Houston motor, may produce results less favourable than the best possible results. An intelligent motor-man can save coal just as an intelligent driver of horses saves hay or horseflesh. The results given above involve the personal equations of average drivers.

PROVISIONAL ORDERS AND LICENCES GRANTED BY THE BOARD OF TRADE DURING 1889.

PROVISIONAL ORDERS.

METROPOLIS.

Name of Applicant.	Title of Order.	Area covered by Order.
The House-to-House Electric Light Supply Company.	House-to-House Electric Light Supply Order.	Two areas within the parish of Kensington, St. Mary Abbot.
The Kensington and Knightsbridge Electric Lighting Company.	Kensington and Knightsbridge Electric Lighting Order.	A portion of the Parish of Kensington, St. Mary Abbot, and the detached portion ef the Parish of St. Margaret, Westminster.
The London Electric Supply Corporation.	London Electric Supply Corporation Electric Lighting Order.	Parishes of: St. James, Westminster. St. George, Hanover-sq. Chelsea (except the detached portion). Rotherhithe. Clerkenwell. Bermondsey. St. Mary, Newington. Lambeth (portion north of Westminster Bridge-road). St. Martin-in-the-Fields (portion west of St. Martin's-lane and south of the Strand). The united Parishes of St. Margaret and St. John-the-Evangelist, Westminster (the portion north of Victoria-street, Parliament-square, and Bridge-street). The Districts of the following Boards of Works:—Greenwich District, St. Olave's District, St. Saviour's District.
The Metropolitan Electric Supply Company.	Metropolitan Electric Supply Company (Mid-London) Lighting Order.	The Districts of the following Boards of Works:— St. Giles' District. Holborn District. Strand District.
	Metropolitan Electric Supply Company (West London) Lighting Order.	The Parish of St. Marylebone.
The Notting Hill Electric Lighting Company.	Notting Hill Electric Lighting Order.	A portion of the Parish of Kensington, St. Mary Abbot.
The Electricity Supply Corporation.	St. Martin Electric Lighting Order.	The Parish of St. Martin-in-the-Fields.
The Chelsea Electricity Supply Company.	South Kensington Electric Lighting Order.	A portion of the Parish of Kensington, St. Mary Abbot.
The Westminster Electric Supply Corporation.	Westminster Electric Lighting Order.	The Parish of St. George, Hanover-square, and the portion of the United Parishes of St. Margaret and St. John the Evangelist, Westminster, lying to the South of the line of the Metropolitan District Railway.

PROVINCES.

Messrs. Chamberlain and Hookham.	Birmingham Electric Light and Power Order.	A central district of the town of Birmingham.
The Liverpool Electric Supply Co.	Liverpool Electric Lighting Order.	A portion of the City of Liverpool.
The Corporation of Swansea.	Swansea Electric Lighting Order.	Swansea.

LICENCES.

METROPOLIS.

Name of Applicant.	Name of District.
*Kensington Court Electric Lighting Company.	Part of the Parish of Kensington, St. Mary Abbot.

* This Licence was superseded by the Kensington and Knightsbridge Electric Lighting Order.

PROVINCES.

Corporation of Dublin (Public purposes only).	A portion of the City of Dublin.
Wimbledon Local Board.	Wimbledon.

Digitized by Google

ELECTRIC LIGHTING NOTICES FOR 1890.

The following is a corrected list of the applications for Provisional Orders deposited with the Board of Trade on or before the 21st of December, 1889. The number of applications, it will be noticed, has been reduced from a total of 179 (see *The Electrician*, December 6th) to 161. Five of the 18 applicants who have dropped their Orders are Local Authorities, and we may expect to see this figure further increased as time goes on. The remaining 13 are mainly companies who have decided not to proceed with their applications in competition with the Local Authorities:—

THE METROPOLIS.

The METROPOLITAN ELECTRIC SUPPLY COMPANY (LIMITED), of Winchester House, Old Broad-street, have applied for two Orders—(1) for the City of London, the parishes of Paddington, St. John, Hampstead, St. Pancras, St. Mary, Lambeth, and so much of the parishes of Clapham and Streatham as is included in the district of the Wandsworth District Board of Works; and (2) for the City of London and its liberties.

The LONDON ELECTRIC SUPPLY CORPORATION (LIMITED), of 3, Adelphi-terrace, Strand, apply for two Orders—(1) for the City of London and its liberties; and (2) for St. Pancras, Islington, Shoreditch, Paddington, Bethnal Green, St. Luke, Middlesex; St. George-in-the-East, Mile End, Hampstead, Hammersmith, Fulham, Whitechapel, Hackney, Limehouse, Poplar, Lambeth, Camberwell, and St. George-the-Martyr, Southwark; Wandsworth, Woolwich, Plumstead, Lewisham, West Ham, and East Ham.

The HOUSE-TO-HOUSE ELECTRIC LIGHT SUPPLY COMPANY (LIMITED), of 117, Bishopsgate-street, E.C., apply for eight Orders, authorising them to produce and supply electricity—(1) in the parish of Islington and the district of the Hornsey Local Board; (2) in the parishes of Fulham and Hammersmith; (3) in the parish of St. Pancras; (4) in the parish of Lambeth; (5) in the district of the Wandsworth Board of Works; (6) in the parish of Paddington; (7) in the districts of the Acton and the Ealing Local Boards; and (8) in Hampstead, Finchley, Hendon, and Willesden.

Application will also be made to the Board of Trade for Provisional Orders on behalf of the LAING, WHARTON, AND DOWN CONSTRUCTION SYNDICATE (LIMITED), of 82A, New Bond-street, W., with respect to the City of London and its liberties.

Messrs. A. AND S. GATTI apply for a Provisional Order to supply electricity for public and private purposes in a portion of the parish of St. Martin-in-the-Fields, and in a portion of the area of the Strand District Board of Works.

The ELECTRIC INSTALLATION AND MAINTENANCE COMPANY (LIMITED), of 4, Great Winchester-street, E.C., apply for a Provisional Order with respect to certain parts of the districts within the jurisdiction of the Lambeth Vestry, the Vestry of Camberwell, the Lewisham District Board of Works, the Beckenham Local Board, and the Croydon Corporation.

The SOUTH OF ENGLAND HOUSE-TO-HOUSE ELECTRICITY COMPANY, of 15, St. Helen's-place, E.C., apply for an Order with respect to Richmond, Mortlake, and Barnes.

Three Provisional Orders will be applied for by the BRUSH ELECTRICAL ENGINEERING COMPANY (LIMITED)—(1) for the City of London; (2) for the parishes of Hampstead, St. Leonard, Shoreditch; St. Pancras, St. James and St. John, Clerkenwell; St. Luke, Old-street, St. Marylebone, St. Mary, Islington; St. Matthew, Bethnal Green; and the districts of Whitechapel, Hackney, and Stoke Newington; and (3) for Hammersmith and Fulham.

Provisional Orders will also be applied for by the St. James and Pall Mall Electric Light Company (Limited), for the parish of St. James, Westminster; by Messrs. Renshaw, King, and Co., and by the City of Westminster Electrical Syndicate (Limited), for the united parishes of St. Margaret and St. John, Westminster; by the Westminster Electric Supply Corporation (Limited), for parts of the parishes of Paddington and St. Marylebone; by the Chelsea Electricity Supply Company for the parish of St. George, Hanover-square; and by the Kensington and Knightsbridge Electric Lighting Company (Limited), for that part of the united parishes of St. Margaret and St. John, Westminster, which is not included in the Kensington and Knightsbridge Electric Lighting Order, 1889, and for the parishes of Paddington, St. Marylebone, and St. George, Hanover-square.

PROVINCES.

Town, &c.	Name of Applicants.
Aberdare	Western House-to-House Electricity Company.
Aberdeen	The Corporation.
	Scottish House-to-House Electricity Company.
Accrington	The Corporation.
Ashton-under-Lyne	Municipal Electric Light and Power Corporation.
Ayr	The Corporation.
Bacup	The Corporation.
Barnsley	The Corporation.
Barrow-in-Furness	Lancashire and Cheshire House-to-House Electricity Company.
Beckenham	Electric Construction and Maintenance Company.
Bedford	The Corporation.
	Midland House-to-House Electricity Company.
Belfast	The Corporation.
Birkenhead	The Corporation.
Birmingham	Birmingham House-to-House Electricity Company.
Blackburn	The Corporation.
Blackpool	The Corporation.
Bognor	Electric Trust.
Bolton	Lancashire and Cheshire House-to-House Electricity Company.
Bootle-cum-Linacre	Lancashire and Cheshire House-to-House Electricity Company.
Bournemouth	Brush Electrical Engineering Company.
	South of England House-to-House Electricity Company
Brighton & Hove	Brighton and Hove Electric Light Company.
Bristol	Brush Electrical Engineering Company.
	Western House-to-House Electricity Company.
Burnley	The Corporation.
Burton-on-Trent	The Corporation.
Bury	The Corporation.
	Lancashire and Cheshire House-to-House Electricity Company.
Cambridge	The Corporation.
Cardiff	Brush Electrical Engineering Company.
	Western House-to-House Electricity Company.
Carlisle	Brush Electrical Engineering Company.
Chatham	*Chatham, Rochester, and District Electric Light Co.
Cheltenham	The Corporation.
	Laing, Wharton, and Down Construction Syndicate.
	Midland House-to-House Electricity Company.
Chester	The Corporation.
Coatbridge	Scottish House-to-House Electricity Company.
Compton Gifford	Devon and Cornwall Electricity Supply Company.
Cork	Irish House-to-House Electricity Company.
Coventry	Midland House-to-House Electricity Company.
Crompton	The Local Board.
Croydon	Croydon Electric Supply Company.
	South of England House-to-House Electricity Company.
Crumpsall	Manchester House-to-House Electricity Company.
Darlington	The Corporation.
	Northern House-to-House Electricity Company.
Derby	The Corporation.
Devonport	Devon and Cornwall Electricity Supply Company.
Dewsbury	National Electric Supply Company.
Dover	The Corporation.
Dundee	The Gas Commissioners and Commissioners of Police.
	Scottish House-to-House Electricity Company.
Eastbourne	Eastbourne Electric Light Company.
Edinburgh	Scottish Electric Supply Company.
Edinburgh and Leith	Scottish House-to-House Electricity Company.
Failsworth	Manchester House-to-House Electricity Company.
Fleetwood	The Improvement Commissioners.
Folkestone	Messrs. Crompton and Co.
Fulwood	Lancashire and Cheshire House-to-House Electricity Co
Galway	Galway Electric Company.
Gillingham	Chatham, Rochester, and District Electric Light Co.
Glasgow	Messrs. Muir, Mavor, and Coulson.
	The Gas Commissioners.
	Scottish House-to-House Electricity Company.
Gorton	Manchester House-to-House Electricity Company.
Great Yarmouth	The Corporation.
Hampton Wick	Hampton Wick Local Board.
Hanley	Birmingham House-to-House Electricity Company.
Harrogate	National Electric Supply Company.
Hastings and St. Leonard's	Hastings and St. Leonard's-on-Sea Electric Light Co.
Hastings	The Corporation.
Hawick	Scottish House-to-House Electricity Company.
Hove	The Hove Commissioners.
	Brighton and Hove Electric Lighting Company.
Huddersfield	The Corporation.
Hull	The Corporation.
Ipswich	Brush Electrical Engineering Company.
Kelvinside	Kelvinside Electricity Company.
Kingston (Surrey)	†The Corporation.
	‡South of England House-to-House Electricity Co.
Lancaster	The Corporation.
Leeds	Electric Installation and Maintenance Company.
	National Electric Supply Company.
	Yorkshire House-to-House Electricity Company.
Leicester	The Corporation.
	Midland House-to-House Electricity Company.
Levenshulme	Manchester House-to-House Electricity Company.
Liverpool	Liverpool House-to-House Electricity Company.
Londonderry	Irish House-to-House Electricity Company.
Malvern & Leigh	The Local Board.
	Midland House-to-House Electricity Company.
Manchester	The Corporation.
	Brush Electrical Engineering Company.
	Laing, Wharton, and Down Construction Syndicate.
	§Manchester House-to-House Electricity Company.

* This application also includes Rochester and Gillingham.

† This application also includes one from the Surbiton Improvement Commissioners and one from the Hampton Wick Local Board to light their respective districts.

‡ This application also includes Surbiton.

§ This application also includes Salford, Crumpsall, Failsworth, Openshaw, Gorton, Moss Side, Stretford, Withington, and Levenshulme.

Digitized by Google

Town, &c.	Name of Applicants.
Margate & Westgate-on-Sea	Municipal Electric Light and Power Corporation.
Morecambe.....	Messrs. T. R. Andrews and T. Preece.
Moss Side	Manchester House-to-House Electricity Company.
Newcastle-upon-Tyne	Northern House-to-House Electricity Company.
Newport, Mon. .	Western House-to-House Electricity Company.
Northampton...	Northampton Electric Light Company.
Norwich	Brush Electrical Engineering Company.
Nottingham ...	The Corporation. Midland House-to-House Electricity Company.
Oldham	The Corporation. Lancashire and Cheshire House-to-House Electricity Co.
Openshaw	Manchester House-to-House Electricity Company.
Oxford.....	Electric Installation and Maintenance Company. Midland House-to-House Electricity Company.
Partick, &c.....	Partick, Hillhead, and Maryhill Gas Company.
Plymouth	*Devon and Cornwall Electricity Supply Company. Electric Trust.
Portsmouth ...	The Corporation. Laing, Wharton, and Down Construction Syndicate. Portsmouth and South Hants Electricity Supply Co.
Preston	†Lancashire and Cheshire House-to-House Electricity Company. National Electric Supply Company.
Reading	Brush Electrical Engineering Company. South of England House-to-House Electricity Company.
Richmond (Surrey)	Brush Electrical Engineering Company. ‡South of England House-to-House Electricity Co.
Rochdale	Lancashire and Cheshire House-to-House Electricity Company.
Rochester	Chatham and Rochester Electric Lighting Company.
Salford	The Corporation. Manchester House-to-House Electricity Company.
Scarborough ...	Brush Electrical Engineering Company. Electric Installation and Maintenance Company. Yorkshire House-to-House Electricity Company.
Sevenoaks	Electric Trust.
Southampton...	South of England House-to-House Electricity Company.
Stafford	The Corporation.
Stockport	Brush Electrical Engineering Company.
Stockton-on-Tees	The Corporation.
Stonehouse.....	Devon and Cornwall Electricity Supply Company.
Stretford.....	Manchester House-to-House Electricity Company.
Sunderland and Southwick	Sunderland and District Electricity Supply Company.
Surbiton	The Improvement Commissioners. South of England House-to-House Electricity Company.
Tiverton	The Corporation.
Torquay	Devon and Cornwall Electricity Supply Company. Municipal Electric Light and Power Corporation (or Company to be formed).
Tunbridge Wells	South of England House-to-House Electricity Company.
Tunstall	Electric Trust.
Walsall	The Corporation.
Wigan	The Corporation.
Windsor & Eton	Windsor and Eton Electric Light Company.
Withington.....	Manchester House-to-House Electricity Company.
Woking and Weybridge	Woking Electric Supply Company.
Wolverhampton	The Corporation.
Worcester	The Corporation. Midland House-to-House Electricity Company.
Wrexham	Wrexham and District Electric Supply Company.
York	The Corporation. National Electric Supply Company. Yorkshire House-to-House Electricity Company.

The following list shows the number of applications which have been served by each Company individually, as well as those by Local Authorities:—

Name of Company.	No. of Applications.
Andrews and Preece, Messrs.	1
Birmingham House-to-House Electricity Company	2
Brighton and Hove Electric Light Company	1
Brush Electrical Engineering Company	14
Chatham, Rochester and District Electric Light Company	1
Chelsea Electricity Supply Company	1
City of Westminster Electrical Syndicate	1
Crompton and Co., Messrs.	1
Croydon Electric Supply Company	1
Devon and Cornwall Electricity Supply Company	2
Eastbourne Electric Light Company	1
Electric Installation and Maintenance Company	4
Electric Trust	4
Galway Electric Company	1
Gatti, Messrs. A. and S.	1
Hastings and St. Leonard's Electric Light Company	1
House-to-House Electric Light Supply Company	8
Irish House-to-House Electricity Company	2
Kelvinside Electricity Company	1
Kensington and Knightsbridge Electric Lighting Company	1
Laing, Wharton, and Down Construction Syndicate	4
Lancashire and Cheshire House-to-House Electricity Company	7
Liverpool House-to-House Electricity Company	1
London Electric Supply Corporation	2
Manchester House-to-House Electricity Company	1
Metropolitan Electric Supply Company	2
Midland House-to-House Electricity Company	8
Muir, Mavor, and Coulson, Messrs.	1
Municipal Electric Light and Power Corporation	3
National Electric Supply Company	5
Northampton Electric Light Company	1
Northern House-to-House Electricity Company	2
Partick, Hillhead, and Maryhill Gas Company	1
Portsmouth and South Hants Electricity Supply Company	1
Renshaw, King, and Co., Messrs.	1
St. James's and Pall Mall Electric Light Company	1
Scottish Electricity Supply Company	1
Scottish House-to-House Electricity Company	6
South of England House-to-House Electricity Company	7
Sunderland and District Electricity Supply Company	1
Western House-to-House Electricity Supply Company	4
Westminster Electric Supply Corporation	1
Windsor and Eton Electric Light Company	1
Woking Electric Supply Company	1
Wrexham and District Electric Supply Company	1
Yorkshire House-to-House Electricity Company	3
	116
Local Authorities	45
	161

*This application also includes Devonport, Stonehouse, and Compton Gifford.
†This application also includes Fulwood.
‡This application also includes Mortlake and Barnes

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-night) FRIDAY, January 3rd.

LONDON INSTITUTION.

4 p.m. Lecture: "Soap Bubbles, and the Forces which Mould Them." By C. V. BOYS, F.R.S.

SATURDAY, January 4th.

ROYAL INSTITUTION.

3 p.m. Lecture: "Electricity." By Prof. A. W. RÜCKER, M.A.

MONDAY, January 6th.

LONDON INSTITUTION.

5 p.m. Lecture: "Egyptian and Assyrian Marbles in the British Museum." By LOUIS FAGAN.

TUESDAY, January 7th.

ROYAL INSTITUTION.

3 p.m. Lecture: "Electricity." By Prof. A. W. RÜCKER, M.A.

ROYAL VICTORIA HALL.

8:30 p.m. Lecture: "A Visit to the Chief Cities of Italy." By Rev. W. W. EDWARDS.

WEDNESDAY, January 8th.

CIVIL AND MECHANICAL ENGINEERS' SOCIETY.

7 p.m. Annual General Meeting. Paper to be read at the subsequent Ordinary Meeting:—"Notes on Prices for Labour and Materials in India." By H. H. PARKINSON, A.M.I.C.E.

SOCIETY OF ARTS.

7 p.m. Juvenile Lecture II.

ROYAL MICROSCOPICAL SOCIETY.

8 p.m. Ordinary Meeting. Paper to be read, "On the Variations of the Female Reproductive Organs, especially the Vestibule in Different Species of Uropoda." By A. D. MICHAEL.

THURSDAY, January 9th.

ROYAL INSTITUTION.

3 p.m. Lecture: "Electricity." By Prof. A. W. RÜCKER, M.A.

LONDON INSTITUTION.

6 p.m. Lecture: "Birth and Growth of Worlds." By A. H. GREEN, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary Meeting. Inaugural Address by the President, Dr. John Hopkinson, F.R.S.

FRIDAY, January 10th.

INSTITUTION OF CIVIL ENGINEERS.

7.30 p.m. Ordinary Meeting. Paper to be read, "The Irrigation Works on the Cauvery Delta." By Alfred Chatterton, B.Sc.

Digitized by Google

The Electrician.

Published every Friday. Price Fourpence; Post Free, Fourpence Halfpenny

Editorial, Publishing and Printing Offices:

No. 1, SALISBURY COURT, FLEET STREET, LONDON, E.C.

Telephone No. 2714. Telegrams: "ELECTRICIAN NEWSPAPER, LONDON."

All Communications to be addressed to "THE ELECTRICIAN," *1, Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN."

All letters intended for insertion in "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. Subscribers should receive their copies by the first post on Friday morning.*

"THE ELECTRICIAN" *is on sale at the railway bookstalls throughout the United Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices as above.*

SPECIAL NOTICE.

Owing to the increase in the number of pages of "THE ELECTRICIAN," in order to partly cover the increased postage, we have been compelled to revise the rates for Foreign Subscriptions, which are now as follows:—

	3 months.	6 months.	12 months
	s. d.	s. d.	s. d.
For Foreign Parts and Colonies:—			
Within Postal Union	6 6	12 6	24 0
Aden, Borneo, Ceylon, China, India, Japan, Java, Labuan, Mozambique, New Caledonia, Persia, Philippine Islands, Siam, Transvaal, and Zanzibar	7 6	14 6	28 0
The rates for the United Kingdom remain as follows:—	5 0	10 0	19 6

TO ADVERTISERS.

"THE ELECTRICIAN" *offers exceptional advantages to Advertisers.* **It has the largest circulation of any English Electrical paper, and circulates all over the World.**

Particulars relating to Advertisements will be promptly forwarded on application to the office.

TRADE ADVERTISEMENTS *intended for the current issue must be handed in not later than First Post on Thursday morning.*

SMALL PREPAID ADVERTISEMENTS *(for Rates see page xiii.) are accepted up to 4:30 p.m. on Thursday.*

TECHNICAL PRINTING.

"THE ELECTRICIAN" PRINTING AND PUBLISHING COMPANY (LIMITED) *beg to inform Electricians, Electric Light Engineers, &c., that they make a specialty of Technical Printing, and have a Staff thoroughly acquainted with Electro-Technology. They can, therefore, promise Accuracy and Despatch in the Printing of Electrical Catalogues and Electro-Technical Literature generally.*

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.

Royal 8vo.

Early in each year is issued "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK. *The* DIRECTORY *was established in 1883, and the 1889 Edition consisted of more than 600 pages of printed matter. The names and addresses of all persons engaged in the Electrical Industries may be relied upon as accurate. Useful Tables and Electrical Formulæ, and information specially compiled for this work are given, together with popularly-written Biographical Notices of the leading Electricians, Electrical Engineers, &c., accompanied in many cases by Portraits.*

The issue for 1890, which will be still further enlarged and improved, is in active preparation. New Names and Addresses, Corrections, Advertisements, &c., should be forwarded at once to the Publishing Office, **1,** *Salisbury-court, Fleet-street, London, E.C.*

CONTENTS OF THE CURRENT NUMBER.

NOTES	207	Summary of Electrical Events for 1889	222
Magnetism in Iron and other Metals.—II. By Prof. J. A. Ewing, F.R.S. Illustrated. Continued	210	New Companies Registered in 1889	225
The Manwaren Electric Meter. Illustrated	212	Companies Wound up in 1889	225
Practical Points in Electric Car Services. By O. T. Crosby	213	American Notes	226
Provisional Orders and Licences Granted by the Board of Trade during 1889	215	CORRESPONDENCE—	
Electric Lighting Notices for 1890	216	Electrifying Steam.—Shelford Bidwell	227
Meetings of Scientific Societies.	217	Underground Mains.—"A Practical Electrical Engineer"	227
1889	218	The Electric Light in English Towns.—C. H. Y.	227
Electric Railways and Tramways in the United Kingdom	221	Robey Electric Lighting Engines. Illustrated	227
The Central Lighting Stations of the United Kingdon	222	Trade Notes and Notices	228
		PATENT RECORD	229
		City Notes, &c.	229
		Companies' Share List	230

OUR SUPPLEMENT.

With this Issue of "The Electrician" we present our Subscribers with a MAP showing the Metropolitan areas at present allotted to the various Electric Light Supply Companies.

Subscribers should receive this Supplement Gratis, and complaints of non-receipt should be at once addressed to "The Publisher."

"THE ELECTROTECHNISCHE-ZEITSCHRIFT" OF BERLIN.

In future the above journal (with which has been incorporated "The Centralblatt für Electrotechnik") will be issued weekly instead of fortnightly, the price remaining **£1** *per annum.*

"THE ELECTRICAL WORLD" OF NEW YORK.

"THE ELECTRICAL WORLD" OF NEW YORK *can be obtained from "THE ELECTRICIAN" Office, Salisbury-court, Fleet-street, London, E.C. The Rate of Subscription (payable in advance), is* **£1 1s.** *per annum. Single Copies* **price 6d. each; post free, 8d.**

"THE ELECTRICIAN" PRINTING AND PUBLISHING COMPANY, Ltd., *are Agents in Great Britain for both the above well-known journals, and particulars as to Advertisements will be supplied on application to "The Publisher," 1, Salisbury Court, Fleet Street, E.C.*

1889.

The year 1889 will long be memorable in the annals of electric lighting in England as one in which was witnessed an outburst of electrical activity, rivalling to some extent the great railway mania of 1846. In the early part of the year attention was mainly concentrated on the proceedings of the different supply companies who were competing for the honour and profit of illuminating the metropolis. The necessity of deciding upon some general principle by which they should be guided in allocating metropolitan areas, together with the great variety of systems proposed and the conflicting demands of the vestries, led the Board of Trade to set on foot an exhaustive inquiry into the applications of the various companies. This inquiry was opened at the Westminster Town Hall, on April 3rd, and extended over 18 days. It was ably conducted on behalf of the Board of Trade by Major Marindin, R.E., assisted by Major Cardew, R.E. The questions of high and low-tension, battery distribution, "districting" and "potential competition," were argued before the Inspector at considerable length, and amongst those examined were Lord Crawford, Sir William Thomson, Sir John Pender, Dr. Hopkinson, Prof. Forbes, and Mr. Ferranti. At the close of the inquiry,

Digitized by Google

Major Marindin announced that he would report without loss of time, and within ten days his report was in the hands of the Board of Trade. Amongst the many points of interest in this very able report, perhaps the most important was the recommendation that for the present, powers should not be given to more than two companies over the same area, and that only one of these should be an alternate-current transformer company. On July 16th the Bills embodying the metropolitan electric lighting schemes came before a Select Committee of the House of Commons, and on the last day of August they received the Royal assent, statutory powers being granted to the London Electric Supply Corporation, the Metropolitan Electric Supply Company, the House-to-House Electric Light Supply Company, the Chelsea Electricity Supply Company, the Kensington and Knightsbridge Electric Lighting Company, the Notting Hill Electric Lighting Company, the Westminster Electric Supply Corporation, and the Electricity Supply Corporation. As soon as their Orders had been confirmed by Parliament, the companies set to work without delay, and the condition of our main thoroughfares soon testified to the fact that the electric lighting of London was at last being seriously undertaken. The demand for current has been most encouraging, and in some instances it has more than kept pace with the supply. Although the districts allotted to the eight successful companies cover several square miles, a large portion of the metropolis, including the City, still remains untouched, and for this virgin territory there are at the present moment no less than fourteen applicants. In spite of the diversity of methods, and the novelty of many of the systems of underground mains, we have up to the present no serious hitch to record; and it may fairly be anticipated that the freedom from accident which has characterised the operations of the metropolitan companies will continue to attend them, so long as the work is carried out with due care and engineering skill.

Turning from London to the Provinces, there is little of note to record during the first half of the year. Towards the end of June, however, electric lighting notices were showered upon the provincial Local Authorities in all directions, nearly 400 notices being served. The attitude taken up by the provincial authorities was at first somewhat antagonistic, and there was a general cry that the lighting, if undertaken at all, should be in the hands of the ratepayers. As soon, however, as the cost of this heroic policy came to be counted, the authorities showed more disposition to allow private companies to carry out the work, under stringent conditions. A large number of Local Authorities, however, persisted in their determination to keep the supply of electricity in their own hands; and the applications of Local Authorities form nearly 30 per cent. of the total of 179 recently sent in to the Board of Trade. Only a small proportion of the applications by Local Authorities can, we think, be deemed genuine: already many of them have been dropped, having served the purpose of fending off private companies, and more will doubtless fall out of the race. Moreover, too much must not be expected even from those Local Authorities who go through with their applications, since many of them are owners of gasworks, and have plainly intimated their intention of preventing the electric light from injuring the ratepayers' gasworks property. A sufficient number of Orders will, however, no doubt be proceeded with to keep our manufacturing firms well employed during the next twelve months. The attitude of many of the provincial authorities towards electric lighting has certainly been ambiguous, but they have in most cases been prompt in coming to a decision one way or the other. As much cannot be said for the Commissioners of Sewers. The question of the electric lighting of the City has been before this body for more than two years, yet it is only within the last month that the Commissioners have been able to allot the western portion of the City to an electric lighting company. The central and eastern districts at the time of writing remain unallotted, though it is *hoped* that they will shortly be dealt with. Five companies are, however, applying for lighting powers within the City, so that it may be anticipated that this policy of delay will not much longer retard the introduction of the electric light into the heart of the metropolis.

Although three decisions affecting leading electrical patents were given during the year, no fresh litigation of importance has been commenced; and it is, we hope, not too much to expect that in future, with so much profitable work to be done, the litigious spirit will be less pronounced. Early in February the Court of Appeal reversed the decision of Mr. Justice Kay and sustained the Edison patent of November 10th, 1879. A month later, the Court of Appeal upheld the decision of Mr. Justice Kekewich invalidating the Gaulard-Gibbs transformer patent. Finally, in June, Lord Trayner, in the Court of Session, held that the Brush compound winding patent, No. 2,003 of 1878, was invalid. Perhaps the most satisfactory event in connection with this array of costly patent litigation was the compromise entered into between the Edison-Swan Company and the Brush Company, whereby an appeal to the House of Lords was avoided.

Activity in all branches of electrical industry, which has formed so marked a feature of the year, has naturally resulted in the formation of a large number of new and the amalgamation of several old companies. Space does not permit of more than a mention of the most important. At the beginning of the year a Company was formed, with a capital of £500,000, to work the Elmore copper depositing process, by which it is claimed that a copper of very high conductivity and great tensile strength is obtained. In June the Electrical Power Storage Company, Messrs. Elwell-Parker, and the Railway Electrical Contractors amalgamated under the name of the Electric Construction Corporation. This company owns the Sprague and the Julien patents for the United Kingdom, and may be expected to push electric traction in an energetic manner. In July an English Westinghouse Company was formed, with a capital of £600,000, and a few weeks later the Anglo-American Brush Corporation amalgamated with the Falcon Engine and Car Works Company and the Australasian Electric Light, Power, and Storage Company, the united companies taking the title of the Brush Electrical Engineering Company. The year 1889 has been especially fruitful in the commercial development of new applications of electricity. In support of this statement we need only mention the Webster electrical sewage process, which has now been for some time in successful operation at Crossness; the electric tanning process of MM. Worms and Balé; the electric welding process of Prof. Elihu Thomson, the great value of which was made widely known by the exhibit at the Paris Exhibition; and Mr. Langdon-Davies' phonopore, which was described in these columns in April last.

The first year of the existence under its new title of the Institution of Electrical Engineers opened with the President's memorable discourse on "Ether, Electricity, and Ponderable Matter." Subsequent Papers, though not, perhaps, so warmly discussed as those of the previous year, have been of great value, and the attendance at the meetings tends to increase more and more. Mr. Mordey's remarkable Paper on "Alternate Current Working," for which he received the "Institution" premium, gave rise to an interesting debate, as did Dr. Lodge's Paper on "Lightning, Lightning Conductors, and Lightning Protectors." The chief point of interest in Mr. Mordey's Paper lay in the formula-disturbing maxim put forward by him and supported by abundant experimental proof that if alternators are made, amongst other things, with

Digitized by Google

the least possible self-induction and the lowest practicable resistance, they will not only be the best alternators, but they will best run parallel. The Institution, moreover, marked the first year of its existence by a meeting in Paris and by a public dinner, at which Lord Salisbury and many other distinguished guests were present. Owing to the success of the dinner it has been decided to make it an annual event. In June a joint deputation from the Institution and the London Chamber of Commerce had an interview with Sir Michael Hicks-Beach, and pointed out the necessity for the establishment of a well-organised Government Standardising Laboratory, and at the present moment this important matter is under consideration by the Treasury.

Among the many events of an eventful year we must not omit to mention the meeting of the International Congress at Paris and of the British Association at Newcastle. The Paris Congress, although a distinct success as a social gathering of electrical workers from all over the world, was by no means of the same scientific importance as that of 1884. The opening meeting of the Congress was held on August 24th, M. Mascart being elected President, and Sir William Thomson Honorary President, and from that day until the close of the Congress on August 31st the various sections applied themselves assiduously to the work in hand. Several decisions with regard to electrical nomenclature were arrived at, the most important being the adoption of the name "quadrant" for the unit coefficient of induction, and of "resistance apparente" (subsequently converted into "impedance" by the Electrical Standards Committee of the British Association) for the ratio of the effective E.M.F. to the effective current. At the British Association, the electrical Papers were less interesting than those of the previous year; but in Section G there were several of great practical value. The Paris Exhibition, the Birmingham Exhibition, the opening of the first municipal central lighting station at Bradford, and the collapse early in the year of the French copper syndicate are all events worthy of notice. It is scarcely necessary to refer to the useful part played by the Electrical Section of the London Chamber of Commerce during the year, the concessions recently obtained from the Executive Committee of the Edinburgh Exhibition by the action of the committee of the Section being fresh in the minds of us all. During the year the number of central lighting stations at work in the United Kingdom has increased from 27 to 46, while electric traction has come into operation at Gravesend, Carstairs, and Barking.

As was to be anticipated, the various engineering and manufacturing firms have been very busy throughout the year, and there is every sign that the present prosperous condition of affairs will be maintained during the coming year, and to show this we cannot do better than give in brief some of the reports kindly furnished us by leading firms. Messrs. Immisch and Co. report a steadily increasing demand for electrical plant for lighting and transmission of power, both at home and abroad. During the year this firm has more than doubled the output of the preceding twelve months. Amongst the plants turned out by this firm are a 70 horse-power hauling plant, for St. John's Colliery, Normanton; a 30 horse-power pumping and hauling plant for Llanerch Pit, Pontypool; a 30 horse-power pumping plant for the Shale Mines at West Calder; a 35 horse-power pumping and winding plant for tin mines in Bohemia; a 40 horse-power fan driving plant for Bohemia, &c. In connection with the Electric Traction Company, Messrs. Immisch and Co., as chronicled in these columns, have been running self-contained tramcars on the North Metropolitan lines between Barking and Canning Town continuously for more than seven months At the end of November, when five cars were running, the horses were withdrawn, and the service depended entirely upon the electric cars. Each car makes on an average 60 miles per day, so that the possible car mileage per week is about 2,100. The total mileage yet made is about 40,000 miles. The cars have kept the schedule time within about 2 per cent. The engineers report that the Electrical Power Storage Company's plates are standing the rough usage much better than expected. Indeed, the chief difficulty experienced has been due to faulty burning of the lugs to the cross bars. Since the cells have now been in practically constant use for about seven months, the figures obtained are of some commercial value in estimating the probable cost of electric traction by accumulator cars. After carefully considering these, the Electric Traction Company feel satisfied that their original estimate of 4½d. per car mile is well within the mark. Messrs. Immisch's fleet of electric launches on the upper reaches of the Thames have met with great success, and in July and August the demand was so great that the resources of the Company were taxed to their utmost. Next season it is intended to increase the number of launches and stations.

The United Electrical Engineering Corporation has also been fully employed. A rigid rail Telpher line, having the exceptionally heavy grade of uniformly 1 in 11·5 has been erected from the Wood Green station of the Great Northern Railway up the hill to the Alexandra Palace. A line of a little over a mile and a quarter in length for the transport of 1,000 tons of tin ore per week is now in course of construction at the well-known Eastpool tin mine in Cornwall, and an order is also in hand for an equipment of a Telpher line in Rome. Contracts are, moreover, in the course of active negotiation for lines in South Africa. The prospects for the coming year are particularly favourable. Messrs. Crompton and Co. (Limited) have during the year carried out the whole of the contract work for the Kensington and Knightsbridge Company, including the erection and part equipment of two large central stations, each of which when complete will be on a scale sufficient to supply 130,000 10 candle-power lamps. These two stations are on the battery-transformer system. The underground mains already laid on Mr. Crompton's system are eight miles in length. At Chelmsford they have just on completion a central station for lighting the town on the alternating-transformer system. At Northampton they have secured the order for and are just commencing work on a central station on the battery-transformer system. At Swansea they have secured the order for and are just commencing work on a central station on the same system. At Port Barry they have nearly completed a central station on the combined high-tension series arc-lighting and alternating-transformer system. They have secured the contract and are now commencing work on a similar station at Folkestone, and have secured a contract for a central station for the Westminster Electric Supply Corporation. In addition to contracts for the complete supply of central stations, they have obtained large orders for plant of the same nature for the Central Argentine Railway; for a central station in Sweden; the Liverpool Electric Supply Company; and, finally, the Crompton Electric Supply Company of Australia. They have manufactured during the year a considerable quantity of depositing and metallurgical plant. Among these may be mentioned a very large dynamo, 2,500 amperes and 60 volts. They have supplied several sets of plant to the English and Dutch Admiralties. They have fitted up 11 steam ships complete, and supplied the steam dynamos for the White Star ships "Teutonic" and "Majestic." These two last are probably the lowest speed direct-driven sets ever constructed, the actual running speed being 170 revolutions for 110 volt lamps. In addition to this they have fitted up complete 93 installations, the

Digitized by Google

total number of lamps fitted in these installations being upwards of 11,500. Messrs. Paterson and Cooper report that the volume of their business has greatly increased: not only have more machines been sent out, but the average size is considerably larger than in previous years, while in their instrument department they have been exceedingly busy during the whole of the year. For ship lighting they have supplied a greater number of machines than in former years, both rope-driven and direct-running. Amongst the important installations carried out by this firm in 1889 were those of the Albert Institute, Dundee; the Pondardawe Tin Plate Works, South Wales; the Overton Paper Mills, Greenock; Messrs. J. and B Stevenson's Bakeries at Battersea; the factories of Messrs. Davis, Moore, and Co., Leicester; and the wharves of the Dundee, Perth, and London Shipping Company at Wapping. Messrs. Johnson and Phillips have been exceedingly busy in all departments. The principal increase has been in electric lighting work, and they are just completing Kapp alternate-current plants for three central stations—one for the Metropolitan Company in London, another for Keswick, and a third for Hong Kong. The growth of orders for the "Brockie-Pell" arc lamp has been remarkable. The largest order in London for these lamps is for the General Post Office, where 76 are to be placed in the sorting-room. The patent liquid insulator has also been in great demand during the year for overhead electric light wires. The works of Messrs. W. T. Goolden and Co. have during the year been fully employed in every department. During the year a considerable number of important contracts have been carried out, and others are now in hand, including central station plants, both on the Kapp-Goolden alternating system and with continuous-current plant. This firm has also been busy with electric mining plant. Messrs. Laurence, Paris, and Scott report that their manufacturing business shows promising signs of increasing, and during the year some excellent orders have been filled. This company exhibited at the Birmingham Exhibition, and many orders have resulted therefrom. The firm has now developed several patents, the principal ones being an instantaneous fuse, an improved system of laying underground mains, and an electric meter. This has been worked at for the last twelve months, and has passed through many stages to the present one, which is the outcome of long and tedious experiments, with many forms of working parts. Messrs. Drake and Gorham report extremely rapid progress during the year, necessitating a considerable extension of their offices. The supply and shipping of generating plant for central stations both at home and abroad has developed into an important department, but notwithstanding the increase in the number of central stations there has also been a brisk demand for complete installations, especially for country houses. In installation work Messrs. Drake and Gorham report the completion of the Bank of England, by the addition of two 9 horse-power gas engines to the existing 500-light steam plant; the Prudential Assurance installation, which now numbers 3,500 lights; Batsford Park, 300 lights; and the Inner Temple, where a 300-light steam plant has just been started. A department has been organised for foreign contracts, amongst which attention may be drawn to the Hotel Metropole, Sydney, 800 lights. The makers of electric light engines have also participated in the present activity. Thus Mr. Bumsted, of Hednesford, reports that his works are now more than double the size they were two years ago, and that he is fully employed turning out Chandler engines for electric lighting purposes. Makers of wires for electric lighting and telephone purposes have also been abnormally busy, and several firms report that they have been obliged to greatly increase their plant. In short, 1889 has been a period of exceptional development in almost every branch of electrical industry, and in view of the increasing popularity of the electric light, and of the slow but steady progress of electric traction, it is improbable that the next twelve months will witness any material diminution of activity.

(To be continued.)

ELECTRIC RAILWAYS AND TRAMWAYS IN THE UNITED KINGDOM.

Place.	Length.	System.	Worked by.
In Operation:—	Miles.		
Alexandra Park	½	Telpherage	United Electrical Engineering Company.
Barking	1½	Battery	Elect. Traction Co.
Bessbrook, Newry	3¼	Third Rail (Dr. E. Hopkinson)	Bessbrook and Newry Tramway Company.
Blackpool	2	Holroyd-Smith's Conduit	Blackpool Electric Tramway Company.
Brighton	1	Rails as Conductors	Magnus Volk.
Carstairs	1½	Anderson-Munro	Anderson and Munro.
Glynde (minerals)	1½	Telpherage	United Electrical Engineering Company.
Gravesend	...	Series Conduit System	Series Electric Traction Company.
Portrush, Giant's Causeway	8	Siemens' Third Rail	Giant's Causeway Electric Tram. Co.
Ryde	¾	Siemens' Third Rail	Ryde Pier Company.
In Progress:—			
City of London and Southwark Subway	3½	Dr. E. Hopkinson (Mather & Platt)	City of Lond. & Southwark Subway Co
Eastpool (minerals)	1½	Telpherage	United Electrical Engineering Company.
Projected:—			
Bray Electric Co.	1		
Camden Town and Elephant & Castle	...		
Central London Railway (City and Bayswater)	4¾		
Chesham, Boxmoor, and Hemel Hempstead Tramroads	8	Not yet selected	Chesham, Boxmoor, & Hemel Hempstead Tramroads Co.
Kensington and Paddington	...		
Lanark and Hamilton	15		
Liverpool Overhead Railway	...		
Lancaster and Morecambe	...		
Lynton	...		
North Metropolitan Tramways	...		North Metropolitan Tramways Co.
North-Western and Midland District Auxiliary Railways	7	Series System	Jointly.
Stockwell and Clapham	1		City of Lond & Southwark Subway Co.
Tottenham-court-road and Shepherd's Bush Common	...		
Wellingborough and District Tramroads	2½	Series System	Wellingborough and Dist. Tramways Co.
Experimental:—			
Birmingham	...	Julien Accumulator Cars	Electric Construction Corporation
Clapham, Balham and Tooting (Lon. Tramways Co.)	...	Jarman (Accumulator Car)	Electric Tramcar Syndicate.
South London	...	Jarman (Accumulator Car)	Electric Tramcar Syndicate.

The Edinburgh Exhibition.—The executive council of the Exhibition have issued a set of additional regulations for exhibitors, embodying the terms agreed upon between Mr. Lee Bapty and the Committee of the Electrical Trades Section of the London Chamber of Commerce. The time for receiving applications for space has now been extended until January 13th.

Digitized by Google

From the forthcoming 1890 Edition of "The Electrician" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.]

THE CENTRAL LIGHTING STATIONS OF THE UNITED KINGDOM.

LONDON.

IN OPERATION.

Station.	Name of Company.	System.
Cadogan (Manor-street, Chelsea)	Cadogan Electric Light Co.	Secondary Battery Distribution (E.P.S. Batteries)
Chapel-pl., Brompton-road.....	Kensington and Knightsbridge Electric Lighting Co.	Direct Current and Batteries (Crompton)
Chapel-pl., Westminster	City of Westminster Electrical Syndicate	Direct Current and Alternate - Current Transformers (Goolden)
Chelsea	Chelsea Electricity Supply Co.	Secondary Battery, E. P. S. (King's Patent)
Deptford	London Electric Supply Corporation	Alternate Cur. Trans. (Ferranti)
Grosvenor Gallery	London Electric Supply Corporation	Alternate Cur. Trans. (Ferranti)
Kensington Court	Kensington and Knightsbridge Electric Lighting Co.	Direct Current and Batteries (Crompton)
Lincoln's Inn-fields	Gwynne-Pilsen Co.	Pilsen Arc and Direct Current Incandescent
Paddington	Great Western Railway Co.	Gordon
Queen's-gate-terrace mews	Kensington and Knightsbridge Electric Lighting Co.	Direct Current and Batteries (Crompton)
Rathbone - place, Oxford-street..	Metropolitan Electric Supply Co.	Alternate Current (Parker Alternators and Transformers)
Sardinia-street ...	Metropolitan Electric Supply Co.	Alternate Cur. Trans. (Westinghouse)
Stanhope-street...	Gwynne-Pilsen Co.	Pilsen Arc & Alternate Cur. Trans. (Clerc-Teague)
St. James'	St. James' and Pall Mall Elec. Light Co.	Direct Current (Low Tension
West Brompton...	House-to-House Electric Light Supply Co.	Alternate Current (Parker Alternators and Transformers)
Whitehall	Metropolitan Electric Supply Co.	Direct Current and Batteries

IN PROGRESS.

Station.	Name of Company.	System.
Brixton	Fyfe-Main Co.	Fyfe-Main System
*City	Crompton and Co.	Secondary Battery Transformers (Crompton)
*Crystal Palace and District	Electric Installation & Maintenance Co.	Secondary Battery, E.P.S. (King's Patent)
Manchester-square	Metropolitan Electric Supply Co.	Alternate Current (Parker Alternators and Transformers)
*Notting Hill	Notting Hill Electric Light Co.	Secondary Battery Transformers
Southwark Bridge	Metropolitan Electric Supply Co.	(Not Selected)
St. John's Wharf, Westminster ...	City of Westminster Electrical Syndicate	Direct Current and Alternate - Current Transformers (Goolden)
Waterloo.....	Metropolitan Electric Supply Co.	Alternate Cur. Trans. (Kapp)

* Those marked with an asterisk are only projected.

SUMMARY OF ELECTRICAL EVENTS FOR 1889.

JANUARY.

Paper on "Lightning Arresters and the Photographic Study of Self-Induction," read before the American Institute of Electrical Engineers by Mr. E. G. Acheson (8th).

First issue of the new fortnightly technical journal *The Telephone and Review of Electrical Science.*

First issue of the new monthly technical journal *Electric Power* (New York).

Opening of the Edison "up town" stations in New York.

Introduction of the Telephone into the Stock Exchange.

Exposure of the "Electric" Sugar Frauds.

Sir William Thomson's Inaugural Address before the Institution of Electrical Engineers, on "Ether, Electricity, and Ponderable Matter" (10th).

Appeal of Messrs. Gaulard and Gibbs against the judgment of Mr. Justice Kekewich, given on July 9, 1888, invalidating their transformer patents (12th).

The Leamington Town Council resolve to give twelve months' notice to the Midland Electric Light Company to determine the contract for lighting the streets (14th).

Formation of Elmore's Patent Copper Depositing Company, with a capital of £200,000 (18th).

Important decision of the United States Supreme Court, that an American patent was *not* limited in its duration by the shorter term of the foreign patent. This decision affected some of Mr. Edison's leading patents which had been taken out abroad for shortest period possible (21st).

Paper on "Electric Meters for Central Stations," read before the Society of Arts by Prof. George Forbes, F.R.S. (23rd).

Inauguration of the West Brompton Station of the House-to-House Electric Light Supply Company (24th).

Contract for the Electrical Equipment of the City and Southwark Subway Railway obtained by Messrs. Mather and Platt, of Manchester.

Circular issued by the Board of Trade, calling the attention of the Vestries to the fact that no Company has the right to disturb the streets without it possesses the necessary statutory powers (29th).

Publication of the Report of the Streets Committee of the City Commissioners of Sewers, with regard to the electric lighting of the City.

Publication of the Report of the Special Committee of the Kensington Vestry, appointed to consider matters relating to electric lighting.

Digitized by Google

THE CENTRAL LIGHTING STATIONS OF THE UNITED KINGDOM.

PROVINCES.

IN OPERATION.

Station.	Name of Company.	System.
Barnet	H. F. Joel and Co.	Incandescent Street Lighting
Bath	H. G. Massingham	Thomson-Houston Arcs, and Mordey Alternators and Transformers
Blackpool	Corporation	Siemens' Arcs
Bournemouth ...	Brush Electrical Engineering Co.	Mordey Alternators & Transformers.
Bradford	(Municipal)	Low Tension
Bradford	(?)	Schmidt's Improved Arcs and Incandes.
Brighton	Brighton and Hove Electric Light Co.	Lowrie-Parker Alternators and Lowrie-Hall Transformers
Cardiff	Brush Electrical Engineering Co.	Brush
Chatham	Chatham, Rochester and District Electric Light Co.	Ferranti
Cowpen	Nicholson & Jennings	Arcs and Incandes.
Derby	J. Davis and Son	Low Tension (Accumulators)
Eastbourne	Eastbourne Electric Light Co.	Alter. Current Transform. (Lowrie-Hall)
Exeter	Exeter Elec. Light Co.	Thomson-Houston Arcs, Mordey Alternators & Transfrs.
Galway.....	Galway Elec. Light Co.	Low Tension
†Glasgow	Corporation	Low Tension
Hastings	Hastings and St. Leonards Electric Light Co.	High Tension Direct Cur.; underground wires; Arc & Incan.
Ipswich	Laurence, Paris & Scott	Low Tension
Keswick	Keswick Electric Light Co.	Kapp Alternators and Transformers.
Leamington	Midland Electric Light and Power Co.	Low Tension
Liverpool (3) ...	Liverpool Electric Supply Co.	Low Tension
Newcastle	Newcastle & District Elec. Lighting Co.	
Newcastle	Newcastle-upon-Tyne Electric Supply Co.	Mordey Alternators and Transformers
Norwich	Laurence, Paris and Scott	Low Tension
Reading	Laing, Wharton&Down	Thomson-Houston
Sheffield	Sheffield Electric Light and Power Co.	Thomson-Houston and Mordey Alternators and Transformers
St. Austell	St. Austell Electric Lt. Co. (J. E. Veale)	Low Tension
Taunton	Taunton Elec. Light Co.	Thomson-Houston
Thetford	Thetford Elec. Light Co.	Laurence, Paris and Scott Low Tension
Waterford	Laing, Wharton&Down	Thomson-Houston

IN OPERATION (*Continued*).

IN PROGRESS.

Station.	Name of Company.	System.
*Edinburgh	Brush Electrical Engineering Co.	Brush
Glasgow	Mavor and Coulson	Ferranti
*Leeds	Electric Installation & Maintenance Co.	Secondary Batteries, E. P. S. (King's Patent)
Lynmouth and Lynton	C. Geen	Mordey Alternators & Transformers
Manchester.....	Brush Electrical Engineering Co.	Low Tension
Okehampton	Henry Geen	Low Tension
*Oxford	Electric Installation & Maintenance Co.	Secondary Batteries, E. P. S. (King's Patent)
*Scarborough	Electric Installation & Maintenance Co.	Secondary Batteries, E. P. S. (King's Patent)
Southampton	Southampton Electric Light and Power Co.	Secondary Batteries (Crompton)
*Swansea	(Municipal)	(Not Selected)
Weybridge	Laing, Wharton and Down	Thomson-Houston Alternators and Transformers
Folkestone	Crompton and Co. ...	Combined High-Tension Series Arcs & Alternate-Current Transformers
Northampton	Northampton Electric Light & Power Co.	Battery Transformers (Crompton)

* Those marked with an asterisk are only projected. † City Hall only lighted; no public supply.

FEBRUARY.

Society of Arts Motor Competition Award.

Judgment given by the Appeal Court in favour of the Edison Incandescent Lamp Patent, in the action of Edison-Swan Company *v.* Holland and others. No injunction, however, was issued against the Anglo-American Brush Corporation, who were third parties to the suit (18th).

The City Commissioners of Sewers decide to invite tenders for the electric lighting of the City (26th).

Completion of the new Triplicate Cable between Java and Australia.

The Town Council of Bath decide to have underground in lieu of overhead wires.

Edison Convention held in Kansas City.

National Electric Light Association Meeting at Chicago.

Paper on "Alternate-Current Machinery" read by Mr. Gisbert Kapp before the Institution of Civil Engineers (19th).

Paper on "Some European Central Stations and their Lessons," read by Prof. George Forbes before the Institution of Electrical Engineers (28th).

MARCH.

Judgment of the Court of Appeal in the case of Ferranti *v.* Gaulard-Gibbs, upholding the judgment pronounced by Mr. Justice Kekewich on July 9, 1888, by which the Gaulard-Gibbs' transformer patent was revoked (4th).

Cancellation of the Edison Patents in Canada.

Paper on "Arc Lamps and their Mechanism," read before the Society of Arts by Prof. Silvanus Thompson (6th).

Lecture at the Royal Institution by Dr. Oliver Lodge, "On the Discharge of a Leyden Jar" (8th).

Collapse of the French Copper Syndicate.

The Cheltenham Town Council decide to invite tenders for the erection of a central lighting station (11th).

Visit of the Technical Press to the Series Electric Tramway at Northfleet (13th).

Paper read before the Royal Society by Mr. Shelford Bidwell, "On an Effect of Light upon the Magnetisation of Iron" (21st).

Phonopore Demonstration on a Telegraph Wire between St. Pancras and Leicester (26th).

Inspection of Mr. Webster's Electrolytic Treatment of Sewage by the Technical Press (27th).

Death of Mr. C. H. B. Patey, C.B., Secretary for Postal Telegraphs

Important storage battery patent decision rendered in the United States' Circuit Court by Judge Cox. The two patents of J. W. Swan for the preparation of plates with perforations were declared invalid, and the Faure patent for applying the active material mechanically was narrowed to that in which the active material takes the form of a "paint, paste, or cement." These patents are the property of the Electrical Accumulator Company.

Digitized by Google

APRIL.

Transfer of the Continental Cables to the Government, the price paid for the cables of the Submarine Telegraph Company being £22,330 (1st).
Opening of the Board of Trade Inquiry into the Metropolitan electric lighting schemes (3rd).
Publication of Prof. Forbes' Report to the Electric Lighting Committee of the Paddington Vestry.
The Chelmsford Town Council accept the tender of Crompton and Co. (Limited) to light the public thoroughfares of the borough for five years with 18 1,000 candle-power arcs and 200 32 candle-power incandescents, at a total cost of £873 per annum.
Death of Mr. Warren de la Rue (19th).
Death of Mr. R. S. Newall.
A large number of overhead wires cut down by order of the New York Board of Electrical Control.
Paper read before the Institution of Electrical Engineers by Dr. Oliver Lodge, on "Lightning, Lightning Conductors, and Lightning Protectors (25th).
Completion of the alternative cable to the Cape of Good Hope (30th).

MAY.

Close of the Board of Trade Inquiry into the Metropolitan electric lighting schemes, after having sat for 18 days (1st).
Opening of the Paris Exhibition (6th).
Opening of a central station at Glasgow.
Royal Society Conversazione (8th).
Issue of an electric lighting licence to the Dublin Corporation (9th).
The Boston Board of Aldermen grant permission to the West End Railway Company to use electric traction on all their existing lines.
The London Central Subway Bill for the construction of an electric railway subway between Holborn-circus and Piccadilly came before a Select Committee of the House of Commons (9th).
Experiments at Portsmouth with regard to the use of the electric light in night attacks.
Publication of Major Marindin's Report on the Metropolitan electric lighting schemes (20th).
Annual Meeting of the American Institute of Electrical Engineers in New York (22nd).
Paper on "Alternate-Current Working," read by Mr. W. M. Mordey before the Institution of Electrical Engineers (23rd).
Rejection of the London Central Subway Bill by the Select Committee of the House of Commons (23rd).
Completion of the Telephone Amalgamation Scheme, whereby the National Company bought up the United and Lancashire and Cheshire Companies; the new arrangement taking effect as from May 1st.
Conversazione of the Institution of Electrical Engineers (24th).
Death of M. Gaston Planté (24th).
Consolidation of the Edison Electric Light interests in America.
Completion of the Thomson-Houston Electric Railway at Topeka (Kansas).
The capital of the American Bell Telephone Company increased from $10,000,000 to $20,000,000.

JUNE.

Formation of the Electric Construction Corporation, with a capital of £500,000 in £10 shares. This Company acquired the works and business of Elwell-Parker (Limited), the Electrical Power Storage Company (Limited), and the Railway Electrical Contractors (Limited), together with the Julien and Sprague electric traction patents for Great Britain (4th).
Provisional Order granted to the Corporation of Swansea.
Important letter addressed to the Board of Trade by the London County Council on the subject of the Metropolitan Electric Lighting Schemes (4th).
Board of Trade Inquiry at Dublin to hear an application by the Alliance and Consumers' Gas Company for permission to open certain streets for the purpose of laying electric light cables (6th and 7th).
Royal Society Conversazione.
Issue of the Board of Trade "Model Order."
Deputation to the Board of Trade on the subject of the establishment of an Electrical Standardising Laboratory (19th).
The Brush Patent, No. 2003 of 1878, for compound winding, and a peculiar form of commutator, invalidated by the judgment of Lord Trayner in the Court of Session, Edinburgh (26th). This result arose out of the action of King, Brown, and Co. *v.* Anglo-American Brush Corporation.
During the last few days of June numerous notices of intention to apply for Provisional Orders were served upon the Local Authorities in the provinces by various electric lighting companies.
A large number of electric supply companies registered, amongst them 11 provincial House-to-House Companies, each with a capital of £100,000 in £5 shares.
The Glasgow Corporation decide to apply for electric lighting powers (24th).

JULY.

The Bill for the purchase of the telephone lines by the State passed by the French Chamber of Deputies.
The Board of Trade advised by Major Marindin not to accede to the request of the Dublin Gas Company to be allowed to break up the streets for the purposes of electric lighting.
Issue of the report of the first six months' working of the Electrical Trades Section of the London Chamber of Commerce.
An agreement entered into by the Edison-Swan United Electric Lighting Company and the Anglo-American Brush Electric Light Corporation, whereby the Edison-Swan Company accepted a licence to use the Lane-Fox and other incandescent lamp patents held by the Corporation and agreed to pay the Corporation a royalty; the Corporation, on the other hand, agreeing to give up the manufacture of incandescent lamps in the United Kingdom and to pay the taxed costs of the patent litigation which had taken place between the two companies.
The Metropolitan Electric Lighting Schemes come before a Select Committee of the House of Commons (16th).
Formation of an English Westinghouse Company, with a capital of £600,000 in £10 shares.
Amalgamation of the Anglo-American Brush Electric Light Corporation with the Falcon Engine and Car Works, and with the Australasian Electric Light, Power, and Storage Company; the amalgamated Companies to be known in future as the Brush Electrical Engineering Company (Limited).
The Corporation of Hamilton decide to apply for electric lighting powers.
The Select Committee of the House of Commons on the Metropolitan Electric Lighting Schemes, after having amended the Bills in several particulars, reported to the House (19th).
Circulars issued by the Electrical Section of the London Chamber of Commerce respecting Standard Types of Apparatus and the Proposed Government Standardising Laboratory.
Consolidation of the various Westinghouse electrical interests; the Westinghouse Electric Company to be reorganised under the name of the Westinghouse Electric and Manufacturing Company (Limited).

AUGUST.

Opening of the Electrical and Industrial Exhibition at Bingley Hall, Birmingham (1st).
The streets of Montreal wholly lighted by electricity, 753 arcs and 346 incandescents being employed (1st).
The Metropolitan Electric Lighting Schemes come before a Select Committee of the House of Lords (6th).
Meeting of the National Electric Light Association at Niagara Falls (6th).
Convention of the Edison Illuminating Companies at Niagara Falls.
The Electric Lighting Provisional Orders Bill read a third time in the House of Lords and passed (15th).
Registration of the Brush Electrical Engineering Company (Limited), with a capital of £750,000.
Formation of the Fowler-Waring Cables Company (Limited), with a capital of £200,000. This Company acquired and united the electric cable businesses carried on by John Fowler and Co. (Leeds) and by Mr. R. Waring.
Issue of the Board of Trade Rules with regard to overhead wires (22nd).
Opening of the International Congress of Electricians at Paris (24th).
Royal Assent given to the Metropolitan Electric Supply Bill (26th).
The Fleetwood Improvement Commissioners decide to apply for a Provisional Order.
Royal Assent given to the Electric Lighting Provisional Orders (Nos. 2, 3, 4, and 5) Bills (30th).
The Dublin Corporation decide by 38 to 3 votes to apply for sanction to borrow £50,000 to carry out the provisions of their electric lighting licence.
The Corporations of the following towns decided during the month to apply for Electric Lighting Powers:—Huddersfield, Leicester, Manchester.

SEPTEMBER.

The French Government take possession of the telephone system of France (1st).
Completion of the Vienna-Prague Trunk Telephone Line, a distance of nearly 200 miles (6th).
The fifty-ninth meeting of the British Association, Newcastle-on-Tyne (11th).
Death of Mr. Cyrus Legge, one of the promoters of the Atlantic Cable (19th).
Opening of the Bradford Municipal Central Lighting Station (20th).
Meeting of the American Association for the Advancement of Science at Toronto.
Meeting of the National Telephone Association at Minneapolis.
Paper on "A New Alternating-Current Motor," read before the American Institute of Electrical Engineers by Lieut. J. F. Patten (10th).

Digitized by Google

The Corporations of the following towns decided during the month to apply for electric lighting powers :—Chester, Hove, Lancaster, Walsall.

OCTOBER.

Publication of the Paris Exhibition Awards.
The Canning Town Section of the North Metropolitan Tramway Company's system worked entirely by the accumulator cars of the Electric Traction Company (1st).
Meeting of electrical engineers and linemen to discuss the formation of an Electrical Trades Union (5th).
Death of Dr. Joule (10th).
Death of Sir Daniel Gooch (15th).
Death of M. Louis Curchod, Director of the International Telegraph Bureau (18th).
The Edison Incandescent Lamps Patent upheld in the United States Circuit Court at Pittsburgh.
The Taunton Electric Lighting Company decides to increase its capital to £20,000 (21st).
Violent agitation in New York on the subject of overhead wires, consequent upon the death of a lineman due to his coming in contact with an electric light circuit.
Consolidation of the Brush Company of Cleveland and the Thomson-Houston Company of Boston.
The Corporations of the following towns decided, during the month, to apply for electric lighting powers :—Aberdeen, Airdrie and Coatbridge, Bacup, Bedford, Birkenhead, Burslem, Cambridge, Croydon, Dundee, Kingston-on-Thames, Oldham, Nottingham, Stafford, Worcester.

NOVEMBER.

First Annual Dinner of the Institution of Electrical Engineers (4th).
Special Meeting of the Electrical Trades Section of the London Chamber of Commerce, at which several important resolutions were passed relating to the forthcoming Exhibition at Edinburgh (11th).
Formation of the Massachusetts Electric Lighting Association.
The Blackpool Electric Tramway Company declares a 7 per cent. dividend (23rd).
Successful demonstrations of the Phonopore in Spain.
The Corporations of the following towns decided during the month to apply for electric lighting powers :—Burton-on-Trent, Burnley, Derby, West Bromwich, Wigan, Paisley, Wolverhampton, York, Great Yarmouth, Dover, Newcastle-under-Lyme, Barnsley, Wednesbury, Tiverton, Portsmouth, Ayr, Hull, Hastings.

DECEMBER.

Opening of the Municipal Central Station at the Halles Centrales, Paris (1st).
The London County Council vote £2,000 for the equipment of a municipal testing laboratory (3rd).
The City Commissioners of Sewers award the contract for the lighting of the Central District of the City to the Brush Electrical Engineering Company (3rd).
Edison's Canadian incandescent lamp patent upheld on the rehearing of the action brought by the Royal Electric Company of Canada against the Edison Company.
Amalgamation of the Edison General Electric Company and the Sprague Electric Motor Company.
Termination of the Silvertown Strike.
Contract for the arc lighting of the Edinburgh Exhibition awarded to the Brush Company—three hundred and fifty 2,000 candle-power lamps.
During this month a large number of sensational reports of fatal accidents due to electricity reached this country from the United States.

NEW COMPANIES REGISTERED IN 1889.

The following is a list of the more important new Companies dealing with electricity which have been registered during the past year :—

Name of Company.	Capital.
Alcoy and Gandia Railway and Harbour Company	£525,000
Bath Electric Light Company	25,000
Birmingham House-to-House Electricity Company	100,000
Birmingham Safe Deposit Company	20,000
British Tanning Company	70,000
Brompton Electric Fittings Company	2,000
Brush Electrical Engineering Company	750,000
Cambridge University and Town Electric Lighting Company	50,000
Chelsea Electricity Supply Company	100,500
Chili Telephone Company	250,000
Column Printing Telegraph Syndicate	10,000
Crompton Electric Supply Company of Australia	50,000
Crompton-Howell Electrical Storage Company	19,600
Croydon Electric Supply Company	5,000
Devon and Cornwall Electricity Supply Company	100,000
Dutton and Co.	60,000
Economic Gold Extraction Company	175,000
Ecuador Telephone Company	100,000
Electric Arms and Ammunition Company	40,000
Electric Construction Corporation	500,000
Electric Tramcar Syndicate	20,000
Electric Trust	60,000
Electric Wiring and Fittings Company	5,000
Electrical Accessories Company	5,000
Electrical Power Storage Company	200,000
Electricity Supply Company for Spain	100,000
Electricity Supply Corporation	100,000
Elmore's Foreign and Colonial Patent Copper Depositing Syndicate	120,000
Elmore's Patent Copper Depositing Company	200,000
Foreign and Colonial Electrical Power Storage Company	100,500
Fowler-Waring Cables Company	200,000
Galloways	250,000
General Electric Company	60,000
Halifax and Bermudas Cable Company	120,000
Halifax Mutual Electric Light and Power Company	20,000
Henley Telegraph and Electric Construction Company	200,000
Hulett, D., and Co	35,000
Irish House-to-House Electricity Company	100,000
Jensen Electric Manufacturing Company	80,000
Johannesburg Electricity Supply Company	250,000
Kensington and Knightsbridge Electric Light Supply Company	250,000
Keswick Electric Light Company	5,000
Kingston-upon-Hull Electric Lighting and Supply Company	1,000
Laing, Wharton, and Down Construction Syndicate	40,000
Lancashire and Cheshire House-to-House Electricity Company	100,000
Lange and Company	10,000
Leicester Electric Light and Power Company	1,000
Liverpool House-to-House Electricity Company	100,000
Llanelly Electric Light and Power Company	15,000
London Electric Supply Corporation	1,250,000
Manchester House-to-House Electricity Company	100,000
Maquay Syndicate	12,000
Maxim-Weston Electric Company	75,000
Midland House-to-House Electricity Company	100,000
Miners' Lamp Electric Lighting Company	3,000
Mines and General Telpher Company	4,000
Morris Brothers	5,000
Mudge-Marchant Engine Company	131,105
Municipal Electric Light and Power Corporation	25,000
National Electric Supply Company	100,000
Newcastle and District Electric Lighting Company	50,000
Newcastle-upon-Tyne Electric Supply Company	50,000
Northampton Electric Light and Power Company	20,000
Northern Electric Wire and Cable Manufacturing Company	20,000
Northern House-to-House Electricity Company	100,000
Nottingham Electric Light and Power Company	100,000
Notting Hill Electric Lighting Company	100,000
Peru Telephone Company	100,000
Pilsen-Joel and General Electric Light Company (now Gwynne-Pilsen Electric Company)	200,000
Planet Electrical Engineering Company	20,000
Pontypridd Electric Lighting Company	10,000
Portsmouth and South Hants Electricity Supply Company	50,000
Railway Automatic Electric Light Syndicate	10,000
River Plate Electricity Company	500,000
Ruston, Proctor, and Co.	250,000
Scottish Automatic Supply Company	12,500
Scottish House-to-House Electricity Company	100,000
Series and General Electric Traction Company	200,000
South of England House-to-House Electricity Company	100,000
Sunderland and District Electricity Supply Company	100,000
Taylor and Challon	40,000
Western House-to-House Electricity Company	100,000
Westinghouse Electric Company	600,000
Westminster Electric Supply Corporation	100,000
Williamson Electrical and Engineering Company	5,000
Woking Electric Light Supply Company	20,000
Wolverhampton Electric Light and Power Company	50,000
Woodhouse and Rawson United	350,000
Wrexham and District Electric Light Supply Company	20,000
Yorkshire House-to-House Electricity Company	100,000

COMPANIES WOUND UP IN 1889.

Amongst the companies against which winding-up orders have been granted during the past year are the following :—

Electric Apparatus Company.
Electrical Automatic Delivery Box Company.
Luther Hanson and Co.
New Telephone Company.
Schmidt-Douglas Electric Company.
Self-Winding and Synchronising Clock Company.

Digitized by Google

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *December* 21, 1889.

The Overhead Wire Cutting in New York.—The electric light situation in New York has developed another phase during the past week. It will be remembered that about two months ago, at the time it was proposed to begin the wholesale cutting down of the overhead wires, one of the judges interposed with an injunction, under cover of which the local companies removed a large quantity of their underwriters' wire and replaced it with circuits of insulated wire of the latest and most approved insulation. The action of this judge was appealed against by the authorities, and now the General Term of the Supreme Court in this State has reversed the order, and has given the Commissioner of Public Works authority to remove the wires condemned by the Board of Electrical Control. The opinions of three judges are practically summed up in the following:—"Plaintiffs have been guilty of a wilful violation of a manifest duty in allowing these wires to become dangerous. They are without excuse, and when they claim that the destruction of these instruments of death maintained by them in violation of every debt of obligation which they owe to the public is an invasion of their rights of property, such claim seems to proceed on the assumption that nothing has a right to exist except themselves." It will be obvious that this language refers to such circuits as the companies had in use prior to the granting of the injunction, and could hardly be applied with propriety to the new circuits strung lately. But, of course, armed with such an authority, the Board of Electrical Control and the Commissioner of Public Works have rushed to wreak their vengeance on the obdurate companies, and have begun a merciless campaign against all the wires in the district provided with subways. The result is that during the past week the busiest thoroughfares of the city have been alive with gangs of men actively engaged in cutting down and removing poles and wires, and a further result has been that the streets have once more been reduced to darkness. It would have been a kindly act toward the store-keepers to have the circuits remain up during these few days preceding Christmas. As might be expected, the darkness of the streets has been very much of an impediment to shopping at night, and the consequence is that the stores have been crowded to suffocation, and dangerously, during the day time. It has so happened, too, that we have had a spell of infamous weather, heavy snow being followed by rain and fog, so that the heartiest kind of invitation has been extended to the sandbagger and other midnight prowlers to enlarge their spheres of operations in this city. In some of the streets the gas lamps have been restored, but it is really pitiful to see how dark they leave the sidewalks after the brilliant illumination of the arcs. Meanwhile, the local companies are endeavouring to get their underground wires and cables ready as quickly as possible; but it stands to reason that some weeks must elapse before the service can be restored to any state of efficiency. The local companies have, in addition to the expenses attending this work, to stand the loss occasioned by the destruction of their pole lines and aerial wires, whose cost ran into a great many thousand dollars.

The Overhead Wire Question in Boston.—I may supplement what I said with regard to Boston last week with the remark that not the slightest evidence has yet been adduced to substantiate the first report sent out to the effect that the recent disaster started with a fire of electric origin in the head-quarters of the Boston Time Company. As I wrote you, however, there has been a great deal of investigation on the subject, and Mayor Hart has been on a tour of investigation through the country to ascertain what are the methods of regulation for overhead wires in force in other cities. A report has now been submitted to the Board of Aldermen from the Electric Light Committee, in which it is recommended that all dead wires shall be taken down at once; that wires entering buildings shall be protected by proper insulation, or suitable safety fuse protectors; that the wire of the West End Electric Railway shall be protected by guard wires; and that an official shall be appointed by the city, who shall have authority to control and regulate overhead wires, and to remove any wires at any time which he considers to be a menace to public safety. It will be found that the task of removing dead wires is not a light one, for they ramify in every direction in Boston, and have been allowed to stay up even more freely than in New York, where the Board of Electrical Control has, from the first, made war upon them. It may be noted that of telephone wire alone there is a total length of 5,168 miles in Boston, of which more than one-third is still overhead, 400 miles being exposed wires. The New England Telegraph and Telephone Company has, however, been quite active and prompt in getting its wires underground, and is still carrying on the work with as much vigour as possible. It is not unworthy of note that the wires of the Telephone Company have for a few years past been protected by safety fusible strips. The telegraph people have also done considerable underground work in Boston. The prospect now is that they will do much more.

The Electric Railroad Under Snow.—I alluded in the opening paragraph to the fact that we have been visited by a heavy snow storm. It is quite early in the year for snow to visit this part of the country, and hence the trial of the severity of the winter on the new electric roads has come much sooner than it was looked for. The results have been highly satisfactory, especially in Boston, where three long lines are already equipped electrically with apparatus of the Thomson-Houston Company. On all these lines the West End Company employed its electrical snow-ploughs, the result being that the tracks were cleared of snow very effectively, and yet not in the ordinary manner of scattering the snow and the mud all over the street and the passers-by. The cars showed themselves well able to travel on the heaviest grades, despite the greasiness of the rails, and carried their full load under conditions that would have exhausted double teams of horses hauling half the load.

Mr. Dana Greene on the Development of Electric Traction. The New York Electrical Society listened last week to an extremely interesting extemporaneous address from S. Dana Greene, late of the Sprague Company, on the subject of the development of electric traction. Mr. Greene has seen a great deal of service, and was associated with Mr. Sprague in the memorable pioneer work on the Richmond road—which, by the way, has been rescued from the financial sharks who secured control of it, and is being put into condition to do better work than before. In addition to discussing the work that had already been done, Mr. Greene threw out some suggestions as to the lines on which the work might be followed out in the future. Thus he suggested that there would probably be a return to the use of one motor for the car, instead of employing as at present two motors, one on each axle. Of course, this would require a remodelling of the present form of truck, and the mounting upon wheels not less than 36in. in diameter; but he fully believed that the time was coming when we would see a single motor of 40 or 50 horse-power on a single car, and equal to all the strains that could possibly be put upon it. He also advocated increase in the length of the wheel base, and expected to see the substitution of bogie trucks: instancing Boston, where a car is running with a body mounted on a truck having three pairs of wheels. With regard to the overhead system in general, Mr. Greene said that all statistics and results went to show that it effected a saving of 50 per cent as compared with the cost of operation with horses. Respecting the conduit system, Mr. Greene expresses himself in a very hopeful manner; and there can be no doubt that marked improvements are to be expected in this department, several leading inventors, including Mr. Edison, being busily engaged with experiments on this class of work. It is recognised that in a great many of the large cities the feeling against overhead wires is too strong to be overcome. It is also felt by many that the storage battery system is still too uncertain and too expensive, but it is believed that a practical solution of the question can be found in some form of conduit service. The test of the Bentley-Knight system in Boston is not regarded by any one as having been a thorough one or a fair one; for even if the conduit itself had worked well, the fact that it served as gutter for the whole street was enough to condemn

Digitized by Google

it to failure. Mr. Greene also alluded to the storage battery system in a manner far from despairing, but did not consider it applicable to roads with grades of over 5 per cent. It may be noted in this connection that Mr. William Wharton, jun., who enjoyed at one time the advice and assistance of Mr. Anthony Reckenzaun, has been pegging away industriously at the problem in Philadelphia, and that he has now equipped the Lehigh Avenue Street Railway Company's road for operation with storage batteries, there being six cars now ready for service. The largest, which is 30ft. over all, the body being 22ft. long, made its first run very successfully all through the city on December 12th. It has a 15 horse-power motor on each of its two tracks. The smaller cars are 16ft. long, and have two 10 horse-power motors suspended side by side on the truck. A noticeable feature of the car is that the storage batteries are inserted and removed from the cars through the end panels instead of through the side of the car, as has hitherto been the practice. In connection with this road, a handsome car station has been put up, and the equipment is in every way first class. The work is in good hands and the results are looked for with very great interest.

The New Edison Station at Brooklyn.—The work in the fine new Edison station at Brooklyn, New York, receives elaborate treatment in the *Electrical World* this week, which publishes a long and able article on the subject by Mr. C. J. Field, its engineer, accompanied by a large number of illustrations and detail drawings. The station is principally noteworthy for two features. One is the use of high-speed compound engines, Edison stations heretofore having confined themselves to single-cylinder high-speed engines. The Ball engines employed were intended to run at first at 250 horse-power, but it was lately determined to operate them at a maximum capacity of 300 horse-power, and they have repeatedly been loaded without difficulty up to 330 horse-power, reaching these results on an average consumption of about 23lb. of water per horse-power, and 3lb. of coal to the horse-power per hour for the 24 hours. The other special point is the abandonment of feeder equalisers. As Mr. Field points out, these equalisers were not employed in Edison's earlier stations, but were adopted later as a supposed element of economy. Experience has now, however, satisfactorily demonstrated that their merit as an element of economy and close regulation is not as great as was estimated, and hence for some time past the smaller Edison stations have gone back to the original plan. The absence of the feeder equalisers has been met by a more liberal use of copper and by the thorough interlacing of the distribution system, so that pressure is maintained practically constant throughout. The Brooklyn station is the first of the large new Edison stations to get back on the old basis, and has constituted a confirmation of Mr. Edison's well-known opinion that the extra outlay of copper more than counterbalances the longer life of the lamps, as the result of uniform pressure and the decreased loss of energy in the conductors, owing to their lower resistance. In the underground system employed also there are a few improvements, and the iron tubes used have been made larger, so that an increased thickness of insulation is obtained. This station is already commanding a large amount of business, and bids fair to be highly profitable.

CORRESPONDENCE.

ELECTRIFYING STEAM.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reference to Dr. Lodge's letter in *The Electrician*, p. 174, I need hardly say that I was well acquainted with his important work relating to the electrical deposition of dust and the dissipation of fog: indeed, I was present at his lecture at the Royal Institution when it was so ably described and so effectively illustrated.

But after carefully considering Dr. Lodge's experiments, together with the explanation which he gives of them, in connection with my own observations of the effect of electrification upon a steam-jet, I formed the opinion that the phenomena in the two cases were by no means "essentially identical." I may mention three reasons for this conclusion—(1) The smoke-deposition is distinctly a polar effect, while the steam-jet phenomenon presents no indication of polar action. (2) In Dr. Lodge's experiments, electrification for some two or three seconds is necessary to produce sensible condensation: in mine the electrical action is, as far as one can see, instantaneous. I showed at the Physical Society that the full effect could be produced at least eight or ten times in a second. (3) The electrical discharge which acts so conspicuously in the case of the steam-jet, is quite without influence upon the apparent density of a smoke-jet, formed by forcing smoke-laden air through a glass nozzle by means of a foot-blower.—Yours, &c.,

December 30, 1889. SHELFORD BIDWELL.

UNDERGROUND MAINS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read with great interest the article written by Mr. Sayers on the underground mains of the Hastings Electric Light Company. I may mention that I have laid several miles of indiarubber-covered cables underground, and have found them perfectly satisfactory. I have no doubt from the description given that I have used very much the same cable as that used by Mr. Sayers. The chief thing I have found is to be very careful concerning the reaming of the pipes and the drawing in of the cable. It seems hardly possible, but nevertheless I have found it to be a fact, that there are electrical engineers (so called), holding responsible positions in London, who think that there is nothing whatever in underground work, and that any foreman who can open up the road is capable of laying underground mains for electric light. Is it any wonder we hear of failures in underground mains?—Yours, &c.,

A PRACTICAL ELECTRICAL ENGINEER.

London, Dec. 31, 1889.

"ELECTRIC LIGHT IN ENGLISH TOWNS."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the letter over my initials in last week's issue there was an important omission, inasmuch as the remarks referred to the section concerning Liverpool.

That was the first to meet the eye, and as at this time of year there is rather a pressure of business, there was little leisure to scan the whole report; so I can only hope the remainder was less inaccurate than the section I commented on in the last number.—Yours, &c., C. H. Y.

A CORRECTION.—In Mr. James Johnstone's letter on "Flames and Electricity," which appeared on p. 200 of our last issue, the commencement of the last sentence but one should read, "The one end of the tube should be pointed for the gas to burn at, the other end should be," &c., &c.

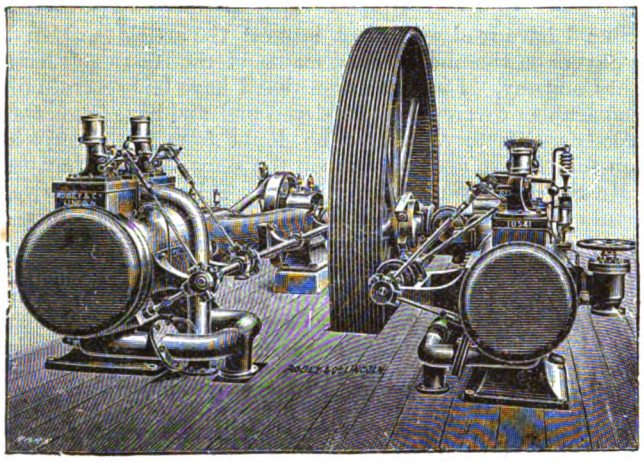
ROBEY ELECTRIC LIGHTING ENGINES.

The illustration below shows one of Messrs. Robey and Co.'s improved coupled compound horizontal fixed engines, fitted with patent automatic trip expansion gear. The engine is specially designed for large, permanent electric light installations, mills, factories, &c. A special feature is the automatic valve gear. The steam is admitted by two Cornish equilibrium valves, one at each end of the cylinder. These are lifted alternately by a fixed eccentric, so as to give a constant lead, while the point of release, and therefore of cut-off, is decided by the governor. The latter is very delicate in its action, and, being relieved of all working strain, is so constructed as to give a wide range of cut-off, with very slight variation in speed. The admission is full, and the cut-off is sharp and distinct at all points. As the valves move almost in equilibrium the friction and consequent wear and tear are reduced to a minimum. The exhaust consists of a special arrangement of Corliss valve, which gives a quick wide opening to the exhaust, with a very small travel, and the exhaust valves being placed under the cylinder, this is kept constantly drained. For electric light installations the valve gear can be controlled by the "Richardson-Nevile" electric regulator, which enables the engine to be controlled by the electric current itself. The valve gear is so arranged that the engine can be stopped by merely pulling a cord, and the engine is designed to work at from 80lb. to 100lb. pressure. High pressure single engines

Digitized by Google

are made of this type from 10 horse-power nominal to 50 horse-power nominal, and coupled and compound engines from 20 to 100 horse-power. The engine will give out the best duty when developing about 2½ times its nominal power, but is made of sufficient strength to work up to four times the nominal power.

Amongst other engines recently designed by Messrs. Robey and Co. for electric lighting purposes may be mentioned (1) a vertical high-speed engine, mounted on a cast-iron bed-plate, the other end of which carries the dynamo. The bed-plate is provided with lugs and adjusting screws, to admit of the driving belt being tightened without stopping the machinery; (2) a horizontal high-speed engine, with bed for dynamo; (3) a high-speed compound horizontal engine, specially designed for driving dynamos either direct or from the fly-wheel. In this engine the moving parts are all made of steel, the piston and rod in one piece, the crank running in very long gun-



Robey Coupled Compound Horizontal Engine.

metal bearings. The working parts are enclosed within the base plate, or hinged cones surrounding the cranks, the lubrication being specially provided for.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning.*]

"The Electrician" Electrical Trades' Directory and Handbook, 1890.—We call the attention of the electrical public to the fact that entries for insertion in the Alphabetical and Classified Trades Sections of the forthcoming edition cannot be inserted in their proper places if received after Tuesday next, January 7th.

Cable for Sale.—The Corporation of Trinity House offer for sale about nine miles of submarine telegraph cable recently used for communicating between Walton-on-the-Naze and the Sunk Light Vessel, together with instruments, &c., connected with the working thereof. Tenders are to be addressed to Mr. J. Inglis, Secretary, on or before Monday, the 27th inst. Further particulars are given on page xiii. of our advertisements.

Mavor and Coulson.—The firm of Muir, Mavor, and Coulson, electric engineers, of Glasgow, of which the subscribers were the sole partners, was dissolved by mutual consent on November 30, 1889. The subscribers, Henry Alexander Mavor and William Arthur Coulson, have acquired right to the business, stock-in-trade, and goodwill of the dissolved firm, and will discharge its liabilities. Mr. Sam. Mavor, who has been with the dissolved firm since 1885, has been taken in as partner, and business will in future be carried on in conjunction with him, at 56, George-square, Glasgow, under the title of Mavor and Coulson.

Telegraph Manufacturing Company, Helsby.—We have received a copy of Catalogue, Section A (Wires and Cables), published by this Company. The Catalogue embodies several new features, and is copyright. It contains a weight and resistance table, a wire price list ready reckoner, sizes of given weights of copper wire, instructions how to determine the size of conductors for electric light and power, some useful formulæ relating to mains, and a number of tables dealing with gutta-percha, india-rubber, vulcanised rubber, compound rubber, lead, silk, and cotton-covered wires, flexible cords, and also gives particulars of the lightning conductors, telegraph, telephone, electric light, military, railway, and elevator cables, manufactured by the firm, besides descriptions of casings, cleats, saddles, wood screws, jointing materials, &c., &c.

Electric Apparatus Company (Limited).—It will be seen by reference to our advertisement columns that the stock-in-trade and goodwill of this Company (in liquidation), of 4, Charing-cross, London, S.W., have been purchased by Woodhouse and Rawson United (Limited), of 88, Queen Victoria-street, London, E.C.

Electric Light Fire Risks.—The North British and Mercantile Insurance Company may now be included amongst the offices who are issuing revised Electric Light Fire Risk Rules, to meet the growing demand for the electric light. We have recently received an advanced proof of these rules, which are necessarily constructed upon the lines of those issued by other offices, such as the Phœnix, Guardian, &c. The rules of the North British are, of course, compiled with the advantage of the experience gained during the past year, and insist upon use of only the best materials, perfect insulation, constant care and attention to details, and the providing of measuring instruments, switches, cut-outs, &c., of the most approved makes. A copious Index is included in the Rules.

——— The 16th Edition of the Phœnix Fire Office Rules regulating the installation of the Electric Light will shortly be issued.

The Société Électricité et Hydraulique.—We have received from the Société Électricité et Hydraulique of Charleroi several illustrated pamphlets describing the different apparatus manufactured by them, including dynamos, arc lamps, gas engines, hydraulic motors, &c. The Dulait dynamo, which is built by this company,

PATENT
SILICIUM BRONZE AND SILICIUM COPPER WIRE.
The best for overhead Telephone and Telegraph Lines,
AND ALL ELECTRICAL PURPOSES.
Hard Drawn High Conductivity Copper Wire.
ROLLED AND DRAWN
PHOSPHOR BRONZE.
PHOSPHOR BRONZE
BEARINGS, BUSHES,
AND OTHER PARTS OF
ELECTRICAL MACHINERY.
SOLE PROPRIETORS of the British, Indian and Colonial Patents,
THE PHOSPHOR BRONZE COMPANY (Limited),
87, Sumner Street, Southwark, London, S.E.
WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

Digitized by Google

is a 4-pole machine, closely resembling the well-known Gülcher dynamo. The chief feature of the Dulait arc lamp is the use of a vibrator device to bring the carbons together. The Société Hydraulique also make a lamp in which the arc is reversed, all the light being obtained by reflection, a system of illumination which they assert is very economical when properly arranged. Another special piece of apparatus is the Pylone Hydro-Électrique, which is a handsome wrought-iron mast supporting a group of arc lamps, in the base of which a small dynamo, driven by a hydraulic motor, is installed. Several of these masts are in use at Liége, the motors being supplied with water at about 80lb. pressure from the town mains.

EDISON ELECTRIC LIGHT Co. (New York).—This Company's sheet, recently received, contains a most formidable list of the isolated plants erected by the Company; companies working the Edison patents under licence from this Company, patents owned by the Company, together with illustrations of Edison dynamos and lamps. The isolated plants, central stations, and municipal plants, represent the respectable total of 1,727 installations and 1,124,686 lamps. A revised set of figures will be issued shortly, when a large increase on these figures may be anticipated.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

December 16, 1889.

20,186. H. W. WILSON. Norwich. Measuring or metering electric currents, as used in houses, &c., for measuring the amount of current used.

20,218. D. B. MORISON. London. Improvements in telephone transmitters.

20,235. E. CORRENS. London. An improved method of and means for the production of the grids of electric accumulators in which the bars narrow from each side inwards.

20,236. W. W. HORN. London. An improved combined electric igniting device and extinguishing device for lamps (M. Carranza, J. M. Sinoco, and Y. Altozano, United States).

December 17, 1889.

20,244. J. H. HOLMES. Newcastle-on-Tyne. Improvements in electric generating machinery for use in connection with the electric lighting of railway trains.

20,260. F. STITZEL, C. WEINEDEL, A. REUTLINGER, M. J. SCHWARTZ, J. H. EGELHOFF, and J. KRIEGER, Senior. Glasgow. Improvements in electric semaphores.

20,261. F. STITZEL, C. WEINEDEL, A. REUTLINGER, M. J. SCHWARTZ, J. H. EGELHOFF, and J. KRIEGER, Senior. Glasgow. Improvements in electric semaphores.

20,266. H. H. LAKE. London. Improvements in and relating to electric spark-rupturing appliances (E. Thomson, United States).

20,268. H. B. TATHAM and J. TATHAM. London. Improvements in conduits for electrical conductors, and in the manufacture of the same.

20,302. T. G. LOVGROVE and J. W. PECHIN. London. Electrically operated alarms.

20,318. A. RECKENZAUN. London. Improvements in electric clocks, also applicable to electricity meters.

December 18, 1889.

20,326. G. KAPP. Manchester. Improvements in and connected with the field magnets of dynamo-electric machines.

20,387. J. D. F. ANDREWS. London. An electric switch.

20,393. C. F. JENKIN. London. Improvements in apparatus for lighting trains by electricity, and in the winding and regulation of dynamos for these and other purposes.

20,400. T. J. MURDAY. London. Improvements in apparatus for obtaining a record of the movements of indicators by means of electricity.

December 19, 1889.

20,451. K. W. HEDGES. London. Improvements in electric safety plugs, and appliances in connection therewith.

December 20, 1889.

20,486. G. E. B. PRITCHETT and H. R. LOW. Stortford. An improved system of distributing electricity by means of secondary generators in conjunction with underground conductors.

SPECIFICATIONS PUBLISHED.

1888.

17,155. LANCASTER. Electrical spring switches. (Price 8d.)

17,178. MORDEY. Electric motors. (Price 6d.)

17,795. BROCKIE. Electric arc lamps. (Price 8d.)

18,035. Sir WM. THOMSON. Electrostatic apparatus for measuring potentials. (Price 11d.)

18,035A. Sir WM. THOMSON. Ampere gauge and connections. (Price 11d.)

1889.

1,673. PHILLIPPART. Secondary batteries. (Price 8d.)

15,489. TEAGUE. Electricity meters. (Price 11d.)

15,820. SMITH. Secondary battery. (Price 8d.)

16,564. LAKE (Morgan). Winding clocks electrically. (Price 8d.)

17,221. TODD and others. Electric telephonic apparatus. (Price 8d.)

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended December 27th amounted to £5,027.

COMMERCIAL CABLE COMPANY.—The numbers are published of the debentures of this Company which have been drawn for payment at par on January 15, 1890, from which date interest will cease.

HALIFAX AND BERMUDAS CABLE COMPANY.—Notice is given that the coupons of the Four and a-Half per Cent. Debentures of this Company, due December 31, 1839, are payable at their bankers', Messrs. Dimsdale, Fowler, Barnard, and Dimsdales, 50, Cornhill, on and after that date. Coupons must be left three clear days.

SPIEL'S PATENT PETROLEUM ENGINE COMPANY (LIMITED).—The annual general meeting of the shareholders of this Company was held, on Monday last, at the offices of the Company, Leadenhall-buildings, E.C. Mr. Frederick Heritage (managing director) occupied the chair, and in proposing the adoption of the report and balance-sheet, stated that the profit and loss accounts on June 30, 1888, showed a debit of £288. 9s. 2d., and that amount had been increased by the sum of £736. 19s. 10d., notwithstanding that the expenses of the Company were still kept within the lowest possible limit, that the rent of the offices had been reduced, and that the Directors still received no fees. In the month of April last, Messrs. Shirlaw and Co. ceased to manufacture Spiel's engines, their right to do so being now the subject of legal proceedings. The Board were hopeful that satisfactory arrangements would shortly be concluded with another firm, who were now making an exhaustive test of the engines at their own works, and in that case there could be little doubt that the success of the Company, so long delayed, would be realised. The motion was seconded by Col. Le Champion, and carried. Mr. D. W. Forbes was re-elected as a Director, and a vote of thanks was accorded the Chairman.

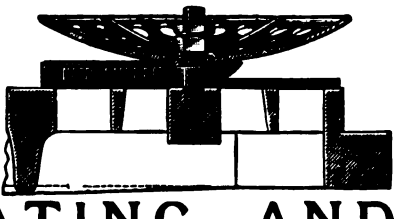
UNITED RIVER PLATE TELEPHONE COMPANY.—The Directors of this Company have declared an interim dividend for the half-year ended September 30th of 2 per cent. (being 2s. per share), tax free, payable on January 15th.

WEST COAST OF AMERICA TELEGRAPH COMPANY.—The Directors of this Company have declared a second interim dividend of 5s. per share in respect of 1889, tax free, payable January 9th.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended December 27th, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,683.

NEW VALVE

No Rubber, Percha, or Leather.



One-half the price of Rubber or Metal.

FOR CIRCULATING AND AIR PUMPS.

Unaffected by any Lubricating Oils. Does not Expand in diameter. Feed Water may be worked at any temperature Suitable for any shaped guards. Only one quality manufactured.

"12, John-street, Sunderland, 26th Sept. 1885.

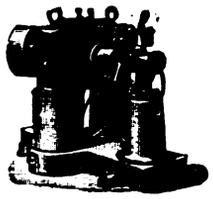
"DEAR SIRS,—In reply to your letter of the 25th inst., the Valves I got from you have done their work well, and ARE AN UNQUALIFIED SUCCESS. I will continue to get them from you as required.—Yours faithfully, JAMES WESTOLL."

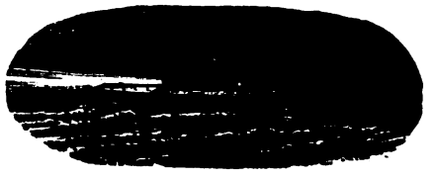
For further Testimony and Prices, apply to MOSSES & MITCHELL, 68-71, Chiswell Street, London.

Digitized by Google

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Tuesday, Dec. 31, 1889.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending Dec. 31, 1889.	
					£ s. d.		Highest.	Lowest.
			TELEGRAPHS.					
£ 1,770,360	Stock	12/6	Anglo-American	51½ 52½	5 4 9	Jan., Apr., July, Oct.	52½	52½
2,614,320	Stock	25/0	Do. Preferred	87 88	6 5 0	,, ,,	87	86¾
2,614,320	Stock	...	Do. Deferred	16¾ 17¼	...	February	...	...
130,000	£10	4/0	Brazilian Submarine	12½ 12¾	5 17 8	Mar., June, Oct., Dec.	12⅝	12 7/16
112,900	£100	5%	Do. 5 per Cent. Bonds	102 104	4 16 2	January and July	...	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	104 107	4 13 6	June and December.	...	...
16,000	10	9/0	Cuba Submarine	14½ 15	6 0 0	February and August	...	...
6,000	10	10/0	Do. Preference 10%	19½ 20½	4 19 9	,, ,,	...	...
12,931	5	2/0	Direct Spanish (£4 paid)	4 4½	4 8 11	March & September	4 1/16	...
6,000	5	5/0	Do. Preference 10%	9 10	5 0 0	April and October	...	...
60,710	20	3/6	Direct United States	10 10½	6 13 4	Jan., Apr., July, Oct.	...	...
330,000	10	2/6	Eastern	14 14½	4 11 3	,, ,,	14 1/16	14
70,000	10	3/0	Do. 6 per Cent. Preference	15¼ 15¾	3 16 2	,, ,,	...	...
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock	105 107	3 14 9	May and November.	106	105
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	107 110	4 10 11	February & August	...	...
250,000	10	2/6	Eastern Extension	13¾ 14	4 12 10	Jan., Apr., July, Oct.	14	13¾
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	102 104	3 16 1	February & August	...	...
473,000	100	5%	Do. 5 per Ct. (Austrln. Gov. Sub.) Debs. 1900	104 107	...	January and July	105½	...
179,177	10	2/0	Globe Telegraph and Trust	8⅝ 8⅞	5 3 9	Jan., Apr., July, Oct.	8¾	...
178,992	10	3/0	Do. 6 per Cent. Preference	14⅜ 14⅝	4 0 8	,, ,,	14⅞	14 1/16
150,000	10	5/0	Great Northern	15⅜ 16¼	4 12 4	Jan., July, and April	...	...
17,000	25	12/6	Indo-European	41 43	5 16 3	April and October	...	...
9,000	8	4/0	Reuter's	7 7½	5 6 5	April and October	6¾	...
15,609	10	5/0	West African Telegraph	9½ 10½	...	...	...	...
300,000	100	5%	Do. 5 per Cent. Debentures	99 102	4 18 0	March & September	...	...
30,000	10	5/0	West Coast of America	11 11½	..	January and July	11½	11⅜
150,000	100	8%	Do. Debentures 8%	119 124	6 9 1	June and December	...	...
88,321	10	nil.	West India and Panama	2⅞ 3⅛	...	...	3	...
34,563	10	12/0	Do. 1st Preference 6%	11⅓ 12	...	April and October	...	...
4,669	10	10/0	Do. 6 per Cent. 2nd Preference	14½ 15½	...	...	...	...
45,181	15	6/0	Western Brazilian	9¾ 10¼	7 6 5	May & November	10	...
$1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	118 122	5 14 9	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	100 102	5 17 2	March & September	...	...
			TELEPHONES.					
224,850	14/0	5%	Consolidated Telephone and Maintenance	1/16 1⅛	...	Yearly	...	...
220,000	£1	3%	Oriental (11s. paid)	7/16 7/16	3 15 11	...	...	...
*	*	...	National	5 5½	...	...	5⅜	5⅛
55,000	5	3/0	United River Plate	4¾ 5¼	...	January and July	...	...
			ELECTRIC LIGHT.					
23,692	5	2/0	Anglo-American (fully paid)	...	...	February & August	...	...
79,934	5	6%	Swan United (£3. 10s. paid)	4⅜ 5⅛	4 0 0	...	5⅛	4 1/16
500,000	10	...	Metropolitan Electric Supply (£3 paid)	4¾ 5¼	...	...	5¼	5
			MISCELLANEOUS.					
87,350	12	12/0	Telegraph Construction and Maintenance	44 46	...	March and July	45⅜	45¼
41,600	10	10/0	India Rubber, Gutta Percha & Telegraph Works	18 19	5 5 3	February & August	...	...





Before Ordering!

ELECTRICAL PLANT & ACCESSORIES

WRITE FOR THE FOLLOWING PAMPHLETS TO THE

UNITED ELECTRICAL ENGINEERING CO., Ltd.

Head Offices: 3, Princes Mansions, VICTORIA ST., WESTMINSTER.

"ELECTRICAL DISTRIBUTION."—Commercially considered, with Estimates.

"MACHINE DRIVING BY ELECTRICITY."—The Uses of Electro-Motors for Traction and Stationary Purposes.

"THE TELPHER SYSTEM OF CHEAP TRANSPORT," for Minerals, Goods and Passengers.

"ELECTRICAL SUPPLIES."—Prices and Particulars of the most approved Electrical Appliances

ELECTRICAL PLANT ON VIEW.

Digitized by Google

THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 603.—Vol. XXIV. FRIDAY, JANUARY 10, 1890. Price Sixpence.

NOTES.

Dr. Hopkinson's work in the domain of magnetism is so well known to the readers of *The Electrician* that his Presidential Address to the Institution of Electrical Engineers, dealing with recent advances in the knowledge of the magnetic properties of iron and other metals, is certain to be welcome. Concerning the address itself we shall have something to say on a future occasion. It is a matter of congratulation that so large a proportion of the recent work has been accomplished by English and English-speaking investigators.

The tenth anniversary of the formation of the Brush Company was celebrated in a manner worthy of the sturdy old company which has so successfully weathered the storms of the past, and which we all hope will have its full share of the present prosperity. The dinner at the Hotel Métropole was, as Sir Frederick Bramwell wittily remarked, conceived in a fine spirit of Christian revenge; for not only were those invited whom one might expect to see present on such an occasion, but among the 150 or 160 guests who enjoyed the hospitality of the Brush Company on Monday evening were some of that Company's doughtiest opponents in the Law Courts, and several of its most formidable trade competitors. The speeches were of the conciliatory and sanguine character usual to after-dinner utterances. Lord Thurlow, in proposing the "Learned and Scientific Societies," alluded in eloquent terms to the debt which commerce owed to science. Sir John Pender, in responding for the "Electrical Industry," dwelt on the difficulties which in early days had beset submarine telegraphy, and prophesied that in the same way as these difficulties were now things of the past, so the few remaining problems which had still to be solved in connection with the electrical distribution of light and power would shortly be overcome. Finally Sir Frederick Bramwell proposed prosperity to the Brush Electrical Engineering Company in one of the most amusing of speeches. In one of the numerous speeches which he was called upon to make in the course of the evening, Lord Thurlow announced that the Brush Company might shortly be expected to declare a dividend. For our part we can only hope that when the time arrives for the Company to celebrate its coming of age, it will be able to show an unbroken succession of dividends dating from the tenth year of its existence.

The St. Pancras Vestry, as we mentioned in our last issue, have finally resolved to give effect to their Provisional Order of 1883, and will shortly advertise for tenders for a central station of 10,000 light capacity. Considering that the population of the parish is some 300,000, a station of this size is by no means too large, even as a beginning. This decision has not been come to without the usual number of reports, since, in addition to a lengthy review of the whole question by Mr. Eccleston Gibb, the Vestry have had before them within the last nine months no less than four reports from Prof. Robinson.

The chief point of interest in Prof. Robinson's final report, which we publish in another column, is the recommendation that the continuous-current transformer system should be adopted. The Metropolis already affords examples of some half a dozen different methods of distribution, and there is no reason why the continuous-current transformer system should not be included among them. It will be noticed that Prof. Robinson bases his estimates on the assumption that 80 Board of Trade units will be sold per lamp per annum. Taking the lamps as 60-watt lamps, this is equivalent to an annual output of nearly 1,400 hours at full load, a figure which is considerably higher than previous experience in this country has shown to be the case. On the other hand, 2,830 tons of coal for an output of 825,000 units, or 6lb. of coal per electrical horse-power hour, ought certainly to be an ample allowance.

In fixing the number of arc lamps for street lighting at 90 the St. Pancras Vestry were guided by the fact that they are permitted by Parliament to make seven per cent. profit, which may be applied to the relief of the rates in any way they think proper. Seven per cent. on an outlay of £50,000 is £3,500, a profit which, according to Prof. Robinson's estimates, can be made by supplying current at 4½d. per unit, and which would pay for the working of 90 arc lamps, while at the same time relieving the rates of the £1,120 at present charged for 400 gas lamps.

We had the pleasure a few days ago of witnessing an interesting demonstration of the capabilities of the Thomson electric welding process. The more one sees of this process the more apparent it is that, except for such *tours de force* as the welding of manganese steel and other refractory alloys, the whole art of electric welding is one which ought to be learned by a man of

Digitized by Google

ordinary intelligence in a comparatively short space of time. Its other great advantages of rapidity, cleanliness, and wide applicability are too well known to need emphasising. The process is now about to be pushed in this country, and we can see no reason for a success less marked than that attained in the United States.

A TERM has long been needed to denote direction along a line, as is so frequently needed in speaking of electric currents, magnetic forces, and many other physical quantities. Such a term has now been coined by the same accomplished hand to which we owe the useful works "torque," "dyne," and "numeric"—Prof. JAMES THOMSON, of Glasgow. The new word is "*ward*," a substantive noun signifying "line and direction in a line: that which is represented ordinarily by a barbed arrow." Sir WILLIAM THOMSON, writing in the *Philosophical Magazine*, uses his brother's term as follows:—"I now define the ward of magnetisation as the ward in which the magnetising force urges a portion of the ideal northern magnetic matter or northern polarity."

NEW processes for the electro-deposition of metals are always worth a trial, especially one for the deposition of iron. The following recipe is given by Messrs. BARTHEL and MÖLLER, of Hamburg. Six hundred grammes of ferrous sulphate ($FeSO_4$) are dissolved in five litres of water; to this is added a solution of 2,400 grammes of carbonate of soda (Na_2CO_3) in five litres of water. The resulting precipitate of ferrous carbonate, $FeCO_3$, is then re-dissolved by the addition in small quantities of strong sulphuric acid, until the precipitate is just dissolved, when the fluid will show a green colour; it is then diluted to twenty litres by adding water. The solution must be faintly acid, turning blue litmus paper deep claret colour, but not red. An iron anode is used.

IN addition to the course of lectures on "Electrical Technology," the syllabus of which we give in another column, Prof. AYRTON proposes between now and Easter to give a special lecture and laboratory course for elemementary school teachers. The introduction of physics into the curriculum of our elementary schools is likely to prove an innovation of somewhat doubtful value, unless the subject is taught in a more practical manner than is the case in the majority of our higher schools. With Prof. AYRTON, however, to teach the teachers, there is no danger of the practical side being lost sight of, and from the teaching of the elements of physics in a common-sense manner nothing but good can come. This course commences on January 25th, and will comprise nine lectures.

Western Union Telegraph Company.—The cables of this company are now repaired.

The Baudot Telegraph.—The line connecting Algiers and Oran is being fitted with the Baudot apparatus.

The Frankfort Exhibition.—The International Electrical Exhibition has been postponed until the spring of 1891.

Paris.—The sum of 32,000 francs was voted at the last meeting of the Municipal Council to defray the expense of fitting the Caisse Municipale with the electric light.

The Commercial Cable Company.—Mr. J. W. Mackay this year gave his usual Christmas present of half-a-month's pay to every member of the staff of the Commercial Cable Company.

The Royal Society.—Among the Papers down for reading at yesterday's meeting was one by Dr. J. A. Fleming, "On Electric Discharge between Electrodes at Different Temperatures in Air and in High Vacua."

Northfleet.—At the last meeting of the Local Board, the Clerk informed the Board that the Gas Company's Bill, of which they gave notice, sought powers to light Rosherville by electricity, in addition to other matters.

Salonica.—A powerful group of financiers is endeavouring to obtain concessions for the electric lighting of Salonica and other Turkish seaports. The proposals of the syndicate are strongly supported by the Government officials.

Keswick.—The Keswick Electric Light Company commenced to supply current to the consumers in the centre of the town and at the Keswick Hotel on Monday night. The light was very steady, and gave the greatest satisfaction.

Torquay.—The Torquay Local Board have decided to oppose the applications of the Devon and Cornwall Electricity Supply Company and the Municipal Electric Light and Power Corporation, with a view to gain time to consider as to the advisability of applying for powers themselves.

A Correction.—The Glasgow Central Station of Muir, Mavor, and Coulson (Limited), which appeared among those in progress in the list on p. 223 of our last issue should have been placed amongst those in operation. Muir, Mavor, and Coulson (Limited) also have a low-tension station in operation in Glasgow.

Birmingham.—The Birmingham Electric Supply Company, which has undertaken to carry out the necessary work in connection with the Provisional Order obtained last Session by Messrs. Chamberlain and Hookham, have decided to at once erect a 5,000-light station. The low-tension system will be employed.

St. Luke's Vestry.—At the last meeting of this Vestry the Clerk read a letter from Messrs. Bircham and Co., on behalf of the Metropolitan Electric Supply Company, stating that it is not the intention of the company to proceed with their proposed application to the Board of Trade to supply electric light in the parish.

The Brussels Tramways.—M. Michelet, manager of the Société des Tramways Bruxellois, has resigned, owing to differences with his colleagues on the question of the employment of electricity. It is thought that the result of M. Michelet's resignation will be a large development of electric traction on the Brussels lines.

The India Rubber Market.—Cablegrams from Brazil say that the rubber market is liable to give out entirely, as the supply on hand is very small. Rubber has advanced from 2,200 to 2,400 reis. The stock is 5,000,000lb. less than it was a year ago, showing that the consumption of rubber is exceeding the production.

The Electric Meter Competition.—*L'Électricien* announces that the report of the special committee charged with examining the electric meters sent in to compete for the municipal prize of 10,000 francs will shortly be laid before the Municipal Council. The special committee, it will be remembered, consisted of MM. Mascart, Hospitalier, Vaillant, Lyon-Alèmand, and Pottier.

Destruction of an Edison Station.—The down-town station of the Edison Electric Lighting Company of New York caught fire on Thursday morning last week, and was completely destroyed, entailing a loss of $100,000 upon the Company. The station occupied two four-story buildings, and supplied current to 18,000 lights. The fire started in the dynamo room, but how it broke out is unknown.

Bridlington Local Board.—At a meeting of this Board on Tuesday last, the Building and Lighting Committee reported

Digitized by Google

that at a meeting held for the purpose of considering the best means of lighting the public streets and places within the district, it was decided to recommend the Board to advertise for tenders for lighting the district either by coal gas or electricity. The report of the Committee was carried unanimously.

Otto von Guericke's Air Pump.—At the last meeting of the Berlin Physical Society the President exhibited the air pump constructed by Otto von Guericke in 1675, which had recently been acquired by the Physical Society. This pump is still in a thoroughly workable condition, with the exception of the glass vessel, which has been renewed. The pressure in this receiver could be reduced to 20mm. of mercury by means of the pump.

The 1889 Prizes of the Academie des Sciences.—At the annual meeting of the Académie des Sciences on December 30th it was announced that the La Caze prize had been awarded Dr. Hertz for his discovery of electric undulations, and of the curious effect of the ultra-violet rays on the electric charge. The Montyon prize for physiological researches was awarded to M. d'Arsonval, mainly on account of his electro-physiological work.

The Telegraph in Bavaria.—The fortieth anniversary of the inauguration of the first Bavarian telegraph line was celebrated at Munich on December 24th. This line was ninety miles long and connected Munich with Salzburg. It was commenced in 1848, completed on November 9, 1849, officially inaugurated on December 24th of the same year, and opened to the public on January 15, 1850. Within ten years of the latter date the line mileage in Bavaria amounted to nearly 4,000.

Eastbourne.—A meeting of the Town Council was held on Monday to consider the recommendation of the Special Committee that the Town Council should apply in the Session of 1891 for a Provisional Order, and refuse their consent to the granting of the proposed Provisional Order of the Eastbourne Electric Light Company. After an animated discussion, it was decided to refer the question back to the Committee and to hold a special meeting of the Council at an early date to finally decide the matter.

The Payen Accumulator.—In preparing his plates, M. Payen prepares an intimate mixture of asbestos fibre and fused chloride of lead and then pours the molten mass into a mould. The material crystallises as it cools, and a chloride of lead plate bound together by the asbestos fibre is the result. The plates are formed in two distinct operations. The chloride of lead is first of all transformed into spongy lead by being made the cathode to an ordinary lead plate as anode. The spongy lead plates are next formed in the ordinary manner, and are then ready to be used.

Berlin.—The Allgemeiner Electricitäts Gesellschaft is extending its conductor system by about 50 kilometres, and a new conductor, consisting of bare copper rods fixed on porcelain insulators in special channels, is to be used. The company is of opinion that this system ensures greater durability as compared with cables, simplicity in extending the network, cheapness, and high insulation. A further advantage claimed is that this conductor will be free to expand and contract owing to the changes of temperature due to the passage of the current, without disturbing the insulation.

Aberdeen.—At the meeting of the Town Council on Monday the report of the deputation on electric lighting was laid on the table. Mr. Cook, who was one of the deputation, said they would have observed that in America the electric lighting had been going out. He had no fear that their gas undertaking, in which they were all so deeply interested, would be imperilled in any way for a great number of years to come. He recommended that the report should be adopted, and that they take power to do a certain thing in a given time, but that would not compel them to do anything at all unless they chose. The report was adopted.

The Notting Hill Electric Lighting Company.—This company, as will be seen by our advertisement columns, is about to come before the public for the subscription of its capital. A compact residential district in the neighbourhood of Holland Park, the rateable value of which is nearly £400,000, was allotted to this company last Session. The chairman of the company is Mr. William Crookes, F.R.S., Mr. R. E. Crompton acts as consulting engineer, and the system employed will be a low-tension one. At the present moment the Notting Hill Company is the only one which has electric lighting powers within this area.

The Clermont-Ferrand Electric Tramway.—An electric tramway connecting Clermont-Ferrand with Royat has recently come into operation. The line is 1½ mile long, and there are 13 stations. Passengers are allowed, for an extra charge of 25 centimes, to carry 50 kilogrammes of luggage. The generating plant comprises a 150 horse-power Farcot engine, a 6-pole separately excited Thury dynamo, giving 350 amperes and 300 volts at 375 revolutions. The current is taken to the cars by an overhead conductor, the rails acting as return. Each car is driven by a 40 horse-power Thury motor. The normal speed is eight miles an hour.

Dundee.—A meeting of the Special Committee of the Town Council, Police Commission, and Gas Commission on the subject of electric lighting was held on Monday. A long explanatory statement by Prof. Ewing was submitted, and it was reported that the only Provisional Order lodged with reference to Dundee, in addition to that of the Gas Commission, was that by the House-to-House Company. The clerk was instructed to issue a circular to the consumers who took £5 worth of gas and upwards, with the view of eliciting whether they would be disposed to take electricity in place of gas if the price of electricity did not exceed once and a-half or twice the price of gas.

The Actino-Electric Effect of the Ultra-Violet Rays.—Among the many investigators into this subject is M. Righi, who attributes the effects to the convection of negative electricity, the charge being separated from the illuminated surface under the influence of the ultra-violet rays, and carried in the direction of the lines of force. M. Righi has shown the existence of this convection by means of aluminium vanes, which were made to move in presence of the rays. The rate of convection, which depends on the capacity of the conductor per unit surface, varied in M. Righi's experiments from 50 to 150 metres per second. M. Righi also succeeded in deviating the convection streams by means of an air blast.

An Electric Gas Governor.—The following is a description of an electrical device for regulating the pressure of the gas in house mains, which was to be seen at work in several parts of the Paris Exhibition. The apparatus consists of an indicating dial and a pair of electro-magnets, the armatures of which actuate a ratchet wheel in opposite directions, closing or opening the gas admission valve as may be necessary. The index of the dial is in connection with one pole of a battery, the other pole being connected through the two electro-magnets to two contacts on the dial. These contacts can be arranged so that a variation in either direction from the standard pressure will bring the lower end of the index against one or the other of the contacts, and the circuit being closed one of the electro-magnets comes into play, and actuates the admission valve. This form of governor is said to act rapidly and effectually.

An Electrical Apparatus for Determining Melting Points.—The exact determination of the fusing point of oily substances, such as certain kinds of wax, is very difficult, owing to the fact that they pass through an intermediate viscous stage. An electrical apparatus for this purpose has been devised by M. Ferdinand Jean, manager of the Paris Bourse de Commerce, and it was exhibited by him at the recent International Congress of Chemists. The apparatus consists of a U-shaped tube, spread out at one end to receive a sample of the substance to be tested, which is covered with a layer of mercury. Two platinum wires, forming part of an electric-bell circuit, are introduced into each half of the tube, and the tube is then placed in a water bath. When the substance attains its melting temperature it flows into the lower portion of the tube, and the mercury completes the electric-bell circuit. The temperature shown by the thermometer in the bath at the moment the bell rings is taken as the melting point of the substance.

Lightning in Mines.—A short Paper was recently read before the Mining Institute of Scotland by Mr. David Smith, describing the effects of lightning which entered the Drumsmudden pit workings in November of last year. The flash, it appears, was

Digitized by Google

observed when the ascending cage was within twenty yards from the surface. The engineman was rendered powerless, but had the presence of mind to throw himself on the brake lever and so stop the engine. The chainman, signal boy, and other boys also experienced severe shocks, but beyond this no harm was done. During the occurrence a thunderstorm of unusual severity was raging, and balls of fire were seen leaping between the haulage rope and the rails. In the discussion which followed the reading of the Paper several cases were mentioned in which the same phenomena were observed: the explosion of fire-damp in a disused lead mine near Hexham was thought to have been caused by lightning, and the Risca colliery explosion in 1880 occurred during a heavy thunderstorm.

Lectures on Electrical Technology.—The following is the syllabus of the course of lectures on electrical technology which is to be given by Prof. Ayrton on Mondays and Wednesdays, at the Central Institution, during the spring term. These lectures commence on Wednesday next, and as the hour is four in the afternoon, it is anticipated that a large number of professional men and others will attend:—Accumulators: Construction; Testing; Storing Capacity; Output; Life. Electric Lamps, Arc and Incandescent: Construction; Regulation; Testing; Efficiency; Life. Introduction to the Study of Transformers: Direct Current; Alternate Current; Testing; Power; Efficiency. Electric Traction: with Accumulators; with a Stationary Conductor. Absolute Block. Telpherage. The Distribution of Energy Electrically. Practical Use of Accumulators and Transformers, in electric distribution. Comparison of the Various Systems of Distribution and their Relative Advantages. Electric Lighting by the Parallel, Series, and Parallel-Series systems.

Severe Thunderstorms.—On Saturday night last, various parts of Ireland were visited by a storm of unusual severity, accompanied in many instances by thunder and lightning. The Protestant church at Birr was struck by lightning. The porch and pinnacle were torn away. A large hole was made in the roof, and a stone was torn from the side wall and thrown across the church. The interior of the building was completely wrecked. The cottage of a farmer named M'Cole, near Cardonagh, county Donegal, was struck. The tenant's wife and daughter were both killed, while he and his son were injured seriously; the son subsequently succumbed to his injuries. Early on Monday morning several districts in the north of Scotland were visited by a very alarming thunderstorm. At Pitlochry, Crieff, and other parts of Perthshire, the storm was greatly felt. A severe thunderstorm also prevailed over Anglesey and Carnarvonshire. A house near Beaumaris was struck by lightning and demolished. Of the six inmates, five escaped without injury, but the other was hurt by falling fragments.

Tinting Incandescent Lamp Bulbs.—The following recipe is due to Mr. Arthur S. Huey, of Minneapolis:—Prepare the glass by thoroughly washing in soap and water and drying. Then dip in bath (made by beating up the whites of two eggs in one and a-half pounds or pints of water, and filtering) and hang up to dry. Dissolve the aniline colour in photographer's common collodion. Red or blue aniline will form clear solutions, while the green solution will require filtering. Yellow aniline forms a handsome colour, but the surface of the glass presents a frosted appearance after the application. Violet and purple colours may be obtained by combining red and blue in different quantities. When the solution is ready, dip the prepared glass bulbs therein; hang up to dry, and finally pass a current through the bulb for half an hour, that the heat thus generated may harden the coating of the collodion, or place in a current of air. The preparation can easily be removed with alcohol or sulphuric ether, but is not affected by water. Experience has shown that the best results are obtained by not using too much aniline. Make the colour light rather than deep, and apply two or three coats.

St. Margaret's and St. John's (Westminster) Vestry.—At a meeting of this vestry on Wednesday, the Works Committee reported that they had further considered the question of electric lighting in the united parishes. In view of the London Electric Supply Corporation and the Westminster Electric Supply Corporation both having power to lay mains in Victoria-street, some correspondence had taken place with the former as to whether they would be willing to wait until the Westminster Corporation were ready, in order that the two mains might be laid at the same time, and thus minimise the inconvenience to the public by the interference with the pavements and crossings. The London company, however, declined to do so, on the grounds that whilst they wished to complete the work as soon as possible, the Westminster Company might be months before they were ready. The London Company's mains will consist of a concentric cable covered with two sheathings of steel, flexible, quickly laid, and only requiring to be placed 4in under the flagstones, but the Westminster company proposed putting down a brick or concrete culvert, necessarily requiring a trench of considerable size, and taking time to construct. The London Company had begun operations. The report was adopted.

A Recording Compass.—An electrical recording alarm compass has been devised by Mr. H. A. Chase, electrician to the Boston Police Signal Service. The compass is constructed by Messrs. J. P. Cushing and Co., of that city, and consists of two parts, the binnacle and the recorder. The binnacle contains a Ritchie compass, modified to suit requirements, and is located in the pilot house, while the recording and course-directing device is placed aft in the main cabin, the two being connected by a flexible wire cable. The compass has contacts for each point of the compass, a separate wire connecting each point with the recorder located in the cabin. This latter device consists of a number of magnets, one for each point of the compass, and a recording sheet properly ruled to correspond with the points of the compass and time of day, actuated by clockwork at the rate of 18in. for every watch of four hours' duration. Each magnet is connected to a prick point, and every time the circuit of a magnet is closed at the compass, the point is operated to perforate the paper. Connected with the course-selecting device are port and starboard alarm bells, which are sounded in case the vessel deviates any predetermined number of points from her course. The circuit for actuating the entire mechanism is run by means of Gassner dry batteries.

A Simple Method of Measuring Contact Differences of Potential.—Prof. Righi has already shown that ultra-violet radiations reduce to the same potential two conductors, a plate and a piece of netting, applied to each other, the rays being thrown on the netting side. He now points out that this suggests a very simple and convenient way of measuring differences of potential of contact. Note the deflection of an electrometer connected with the plate (the netting being permanently connected with earth); then, having connected the electrometer for an instant with earth, make the radiations act a sufficient time. Prof. Righi used a zinc electric lamp, and the metals examined were placed in some cases in a bell jar, to which some gas or vapour was admitted. From measurements of different plates with the same metallic net (copper, zinc, or platinum), the differences of potential of pairs of metals could be deduced. Prof. Righi found the differences sensibly the same in dry and moist air and in carbonic anhydride; but with hydrogen very different values (from those in air) appeared, where one of the metals examined was platinum, palladium, nickel, or iron (doubtless owing to absorption). In ammonia all the metals, examined with zinc net, seemed to have become less oxidisable; and in coal gas, carbon and platinum behave like more oxidisable metals.

The Electrolysis of Cryolite.—In a paper on "Electrolysis of Cryolite," in the *Journal* of the Chemical Society, Mr. W. Hampe says:—"By the electrolysis of cryolite, or mixtures of cryolite and sodium chloride, some investigators have obtained aluminium bronze, others have not; the success of the former is due to the use of a solid copper negative electrode, and the failure of the latter to the use of molten copper for that purpose. The author's experiments indicate that when the electrolysis takes place near the melting point of copper,

Digitized by Google

bubbles of sodium vapour come off and burn at the surface; any aluminium set free is in such a finely divided state that it almost all combines with the fused cryolite to form the sub-fluoride; but when the electrolysis is conducted at lower temperatures, the sodium separates in a liquid state and gives rise to larger aggregations of aluminium, which consequently expose a smaller proportion of surface, and are less rapidly attacked by the molten cryolite; nevertheless, some is attacked, and the yield of aluminium alloyed with the copper is always much below theory. The alloy has a lower melting point than copper, and therefore melts off the electrode and drops to the bottom of the crucible. By mixing salt with the cryolite, the melting point of the latter is lowered, and the electrolysis may be conducted at a lower temperature.

The Edinburgh Exhibition.—The Executive Council have decided to finally close the list of applications for space on the 15th inst., when allotment will be proceeded with. Amongst the electrical exhibitors are Sir William Thomson, Mr. W. H. Preece, Mr. Edison, the General Post Office, Edison-Swan Company, Laing, Wharton, and Down; Brush Company, Paterson and Cooper, United Electrical Engineering Company, King, Brown, and Co.; Muir, Mavor, and Coulson (Limited); Elmore Copper Depositing Company, Thomson-Houston Welding Company, Newall Engine Company, Robey and Co., Electric Traction Company, Ernest Scott and Co., Ronald Scott, Woodhouse and Rawson, Buller, Jobson, and Co.; W. T. Glover and Co., National Telephone Company, Consolidated Telephone Construction Company, Colonel Gouraud, Gent and Co., Exchange Telegraph Company, Eastern Telegraph Company, &c., &c. The Decauville Company propose to show a narrow-gauge railway in operation, but worked by electricity in lieu of steam. The Executive Council have arranged with Messrs. Immisch and Co. for a 10 minutes service of electric launches on the Union Canal between Fountain Bridge and the Exhibition. In addition to the British Electrical contingent, about 150 electrical exhibits are expected from France, where the Government have officially recognised the Exhibition, and considerable numbers from other foreign countries.

The Fiske Range and Position Finder.—The principle of this apparatus consists in the determination of a fractional portion of a conducting body bearing in length a ratio to the angle included between two lines of sight directed upon some distant object, and the measurement of the electrical resistance of this length. The salient features of the apparatus consist in the determining of the exact range of any distant object by keeping trained upon it a telescope, which in moving carries along with it a dial parallel with the telescope. This dial is electrically connected with a graduated arc over which it moves, and by means of ranging angles registers accurately the distance of the object from the apparatus. An observer, then, stationed at the galvanometer, and at one of the points of resistance, can, by noting the galvanometer and adjusting the resistance in the usual way, determine the resistance equilibrating any portion of the arm along the arc, and so discover the angle of adjustment of this arc; or, having adjusted one of the points of resistance at some given figure, the observer may, by simply noting the galvanometer or any other suitable indicating device, visible or audible, determine when the dial is placed at a desired angle corresponding to the adjusted resistance, and this indicating device is obviously at the place where the moving arm is situated, so that the operator then knows when he has placed the arm at the predetermined point, or at the distant station, so that the operator in charge of the resistance point can know that the arm has been properly adjusted; or two indicating devices in the same circuit may give warning to both operators, as above, simultaneously. By this means the elevation or training of a gun may be determined or recognised from a distant point.

Deep-Sea Fishing by Means of the Electric Light.—In the investigations that were undertaken by the Prince of Monaco in deep-sea soundings an ingenious method was adopted to obtain specimens of the living creatures existing at the bottom of the ocean. The apparatus used was shown at the Paris Exhibition. The cage in which the submarine animals were caught, according to *Le Genie Civil*, consisted of a cylinder of wire having three conical entrances, like those of a lobster pot, and weighted for submersion with detachable weights. It was, however, very unlikely that at these immense depths, where the darkness is practically total, any fish would voluntarily find their way into the trap, and steps were taken to attract them by a light placed inside it. Obviously, no light was available but an electric light, but to get an electric light to burn a mile or two under water was not easy. The only resource was to supply the incandescent wire from a battery in the trap. Here, however, another difficulty appeared. It was necessary to enclose the battery, which had to be of considerable power, in a box of some kind, and as the hydrostatic pressure at such depths was six or seven hundred pounds per square inch, it was found impossible to make a box which was not crushed before it reached its destination. At last, however, this trouble was overcome by the curious device of connecting the box with a balloon. The balloon was made of cloth dipped in indiarubber, and so arranged that the air in it was in communication with that in the battery-box. On sinking the apparatus, the hydrostatic pressure, being virtually uniform all round the balloon, compressed it equally on all sides, forcing the air out of it into the battery-box, until the pressure inside the box and balloon exactly balanced the pressure outside. This process went on to any extent, so that at the bottom of the sea, although the balloon was reduced by the enormous force exerted on it to a small fraction of its original size, it still kept the internal and external pressures equal. On raising the apparatus again it expanded as the pressure diminished, and brought the battery-box to the surface uninjured. So successful was this device, that, not content with capturing deep-sea fish, the Prince and his assistants propose on their next expedition to send down a photographic apparatus and bring back negatives of the bottom of the ocean, as seen by the electric light.

Ships Struck by Lightning.—Up to 1820, when Sir W. Snow Harris commenced his agitation for the use of lightning conductors at sea, ships had practically been without any such protection. It is, therefore, not surprising to find that in the course of about fifty years—from 1793 to 1840—over 200 ships had been struck by lightning. Between 1810 and 1815 the Royal Navy suffered severely, for damage was done by lightning to no fewer than 35 line of battle ships, 13 frigates, and 10 sloops. It was estimated that in 22 years—from 1793 to 1815—the spars of all kinds shattered by lightning and rendered useless were worth about £72,000. In 1813 no fewer than five out of thirteen line of battle ships cruising off the Rhone were struck by lightning on the same night. In some of the old warships an unsuspected source of danger was often to be found. A capstan, having an iron spindle five feet long and six inches in diameter, was placed vertically over the magazine, immediately under which were long metallic bolts, used in the construction of the ship, which passed through the keel into the sea. No arrangement could have been better provided to ensure an explosion. The Harris system of conductors entirely superseded the obsolete chains of Dr. Watson, which stretched from truck to water line when in use, but were more often stowed away. The following are a few instances of the damage caused by lightning to the old badly-protected wooden ships. In April, 1827, the American packet ship "New York," bound to Liverpool from New York, was struck when about 500 miles from the nearest American land. Her old-fashioned conductor was not aloft when she was first struck. Her conductor was then placed in position. It was composed of an iron terminal rod standing up from the royal truck about four feet, to which was attached an iron chain, which trailed in the sea. Again she was struck, and this time the conductor was fused and set the deck on fire, although at the time the rain was falling in torrents. In 1845 a Turkish vessel in the Baltic was struck. Her conductor was aloft, but was not in connection with the sea. A hole, similar to that made by a cannon ball, was made in her side. In 1820, the French corvette "Coquin" had a hole made in her bottom by a stroke of lightning in the Bay of Naples, and but for ready aid must have sunk at her anchors. Finally, the 74-gun ship "Cumberland" required three complete refits and two new mainmasts in the short space of 18 months owing to being repeatedly struck by lightning.

Digitized by Google

DR. JOHN HOPKINSON.

We publish this week a steel-plate portrait of Dr. JOHN HOPKINSON, F.R.S., the newly-elected President of the Institution of Electrical Engineers.

Dr. John Hopkinson is the eldest son of Mr. Alderman Hopkinson, of Manchester, and he was born in the year 1849. His mother is a daughter of the late John Dewhurst, of Skipton. His education commenced at Linden Grove School, and was afterwards carried on at Queenswood College, but he left there at the early age of fifteen and a-half to enter Owen's College, Manchester, where he remained until he was eighteen, when he entered Trinity College, Cambridge.

In the year 1870 he graduated as Doctor of Science in the University of London, taking as his subject Pure and Applied Mathematics, under the original regulations for that degree. In the following year he graduated at Cambridge as Senior Wrangler and First Smith's Prizeman. These two honours have not very often been obtained by the same man, as the Smith's prize examination is essentially a test of mathematical creative power, or capacity for original work; while the mathematical tripos has always been rather to test a man's capacity of assimilating, and reproducing with accuracy and rapidity, the work of others. By obtaining the first place in both examinations Dr. Hopkinson therefore showed that both his receptive and creative mathematical powers were of a very high order, and this early promise has been amply fulfilled throughout his subsequent career. It is a fact not unworthy of notice in these days, when the fierceness of competition leads many ardent young students to commit the fatal mistake of neglecting physical exercise, that while at Cambridge Dr. Hopkinson was known as a good oarsman and runner, and that he won a footrace only three weeks before the commencement of his tripos.

His first published original investigations, on "Thermodynamics" and on "Internal Friction in the Vibrations of Solids," were contributed to the *Messenger of Mathematics* in 1871; and in this and the following year he read two short Papers on "The Rupture of Iron Wire by a Blow," before the Literary and Philosophical Society of Manchester. In the first of these he showed mathematically that cold increases the tensile strength of iron, and that the reason that it makes it more liable to break under impact is that it increases the elasticity in a higher ratio. This and other results arrived at theoretically were fully confirmed by experiments described in the Papers, which are of considerable importance in the historical consideration of Dr. Hopkinson's scientific work, as they show that from the beginning his tendency was to be attracted by problems of practical importance to engineers, and to employ his mathematical powers to lead him by the shortest road to practically useful results, instead of devoting them to the erection of elaborate structures upon hypothetical foundations.

Early in the year 1872 Dr. Hopkinson accepted the appointment of engineer to Messrs. Chance Brothers and Company's lighthouse works, near Birmingham, at which town he lived until 1878, when he moved to London, and began practice as an engineer on his own account—without, however, giving up his connection with the firm, a connection which still continues, and which has resulted in many improvements in lighthouse work: notably the Group Flashing Apparatus. After his removal to London he very soon became widely known as an expert in patent cases, a branch which still forms an important portion of his practice.

In the year 1877 Sir William Thomson communicated Dr. Hopkinson's first electrical Paper to the Royal Society, and it was published in the *Philosophical Transactions*. The Paper dealt experimentally with the residual charge of the Leyden jar and the dielectric properties of different kinds of glass. In the course of this investigation he showed that the more highly conducting kinds of glass conduct electrolytically even at low temperatures. His next Paper, published in the *Philosophical Transactions* of the same year, "On the Electrostatic Capacity of Glass," contained the results of an investigation carried out in order to test the truth of the conclusion deduced by Maxwell from his electro-magnetic theory of light, that the product of the electrostatic capacity, and the magnetic permeability of a transparent substance should be equal to the square of the refractive index for long waves. The results of the experiments were not in agreement with Maxwell's theoretical conclusion; but, as Dr. Hopkinson pointed out in his Paper, they did not in any way disprove the theory in its more general character. A further investigation communicated to the Royal Society in 1880 confirmed the former results, and showed that if there were any change in the electrostatic capacity of glass with temperature it was not sufficient to reconcile Maxwell's theory with the experimental results. Early in 1881 Dr. Hopkinson read another Paper before the Society, "On the Electrostatic Capacity of Liquids," in which he showed that the hydrocarbon oils behaved as required by Maxwell's theory, while the vegetable and animal oils did not. He pointed out, however, at the conclusion of this passage that the time of disturbance in the actual optical experiment was many thousand million times as short as in the fastest electrical experiment. Two short Papers published in 1878 and 1879 are worthy of passing mention, viz., an experimental Paper "On the Torsional Strain which remains in a Glass Fibre after Release from Twisting Stress," which made a sensible advance in our knowledge of the "elastic fatigue," as it is now called, of glass fibres, and was published in the Royal Society's *Proceedings* for 1878. The second was a mathematical Paper published in *The Messenger of Mathematics* for 1879, on "The Stresses caused in an Elastic Solid by Inequalities of Temperature," which explained by means of the ordinary mathematical theory of elastic solids the liability to breakage under slight stresses of badly-annealed glass vessels or of iron castings withdrawn too soon from the moulds, or made in such forms as to cool at very unequal rates in different portions.

During the years 1879 and 1880 Dr. Hopkinson read two Papers of very exceptional importance, "On Electric Lighting," before the Institution of Mechanical Engineers. In the first of these he described a number of experiments made with a Siemens dynamo to determine its efficiency under varying conditions, and mapped out the relations between E.M.F. and current by means of curves, since called "characteristic curves" by M. Marcel Deprez. It was the nature of these curves which led the author to the discovery of the now well-known "magnetic lag." In the second Paper a number of somewhat similar experiments subsequently made by other observers on Siemens and Gramme dynamos, were mapped out in the same way, and the observations were thus made comparable with one another. It also contained descriptions of a method of measuring the brightness of the electric arc, and the determination of the ratio of the potential difference at the ends of the carbons to the current passing. Early in the year 1883 Dr. Hopkinson made some improvements in the Edison dynamo, which proved to be of exceptional importance as forming the basis of subsequent important improvements in dynamo machinery. In the same year he was appointed to deliver before the Institution of Civil Engineers one of a series of lectures on "The Practical Applications of Electricity." His lecture was entitled "Some Points in Electric Lighting," and in addition to a most masterly general exposition of the subject, he developed in it some very important points, such as the possibility of running two or more alternating machines in parallel, and the relations between the efficiency and the dimensions of a dynamo; and he also pointed out that the fact previously observed by Mr. Shoolbred in experimenting with a Gramme machine, that after a certain current strength had been obtained the E.M.F. began to diminish, could be explained by the approach to magnetic saturation of the iron of the machine. The theory of alternating dynamos was further developed in a Paper on "The Theory of Alternating Currents," read before the Society of Telegraph Engineers in 1884.

In 1885 he read a Paper "On the Quadrant Electrometer" before the Physical Society, in the course of which he pointed out that Maxwell's formula did not represent the facts when the potential of the needle was considerable, an observation which has since been confirmed and further investigated by Prof. Ayrton and some of his pupils. During the same year he con-

Digitized by Google

tributed two Papers to the *Philosophical Magazine*, in the first of which, "On an Unnoticed Danger in Certain Apparatus for Distribution of Electricity," he showed the danger of employing secondary generators of large electrostatic capacity, even if the insulation of the primary circuit and of the primary coils from the secondary ones were perfect. The second one was a theoretical Paper "On the Seat of the Electromotive Forces in a Voltaic Cell."

In 1885 and 1889, Dr. Hopkinson read two very important experimental Papers before the Royal Society, "On the Magnetisation of Iron," and "On the Magnetic and other Physical Properties of Iron at a High Temperature." In 1886 he read a very important Paper before the Royal Society, "On Dynamo Electric Machinery." This Paper contained an account of investigations carried out in conjunction with his brother, Dr. E. Hopkinson, with the object of obtaining an approximately complete construction of the characteristic curve of a dynamo of given form from the ordinary laws of magnetism and the known properties of iron, and to compare the results with the actual "characteristic" of the machine. Another very important Paper, "On the Electrical Illumination of Lighthouses," was read before the Institution of Civil Engineers in 1886.

Dr. Hopkinson was elected as a Fellow of the Royal Society in 1878, and he is a member of the Senate of the London University.

In concluding this brief notice of a brilliant and useful career, which we trust may be continued for many years to come, we would call attention to two important lessons which it teaches to those who hope to become engineers, viz.: the incalculably great advantage to a practical engineer of a thorough mathematical and scientific training, and the fact that a practical engineer while occupying a position in the very front rank of his profession can continue to be an investigator of questions of pure science. Such lessons should, indeed, hardly require enforcing; but unfortunately the voice of ignorance makes up in loudness for what it lacks in weight, and thereby frequently leads the inexperienced astray.

THE RATHBONE PLACE STATION OF THE METROPOLITAN ELECTRIC SUPPLY COMPANY.

The Rathbone-place Station, which now forms one of the Metropolitan Company's generating centres, was started in September, 1887, by Messrs. Pritchett. The first machine employed was a 1,000-light Ferranti alternator of 100 volts E.M.F., Mordey transformers being employed to raise the volts to 2,000, at which pressure the distribution was effected, step-down transformers being employed in the usual way on customers' premises. The Ferranti machine was resorted to pending the completion and delivery of two Mordey alternators—the first of their kind. One of these was started in February, 1888, and the other a little later. In February, 1889, the station was acquired by the Metropolitan Company, who at once proceeded to re-design it, and to substitute Elwell-Parker machines for those *in situ*, the new plant coming into operation in November last.

The station comprises the basement and ground floor of a building 118ft. by 44ft. The dividing flooring between basement and ground floor has been removed, so as to give sufficient height for the new machinery. The hall thus formed is fairly high and airy, but the appearance of the station when complete will be marred to some extent by beams, which are necessary for the stability of the building. A new chimney shaft has been run up to a height of 120ft., the size of the flue being 6ft. × 4ft. The Metropolitan Company have employed white glazed bricks for their shafts, including this of Rathbone-place: they find that a white glazed shaft goes up quite cheerfully, where complaints of unsightliness and difficulties about "ancient lights," &c., would crop up in abundance if it were attempted to put up an ordinary brick shaft in the same spot. Evidence of Mr. Gordon's determination to have the whole of the arrangements well up to date is given by the fact that Dr. Oliver Lodge has been consulted as to the form of lightning conductor most suitable. The form recommended by Dr. Lodge consists of four No. 7 B.W.G. galvanised iron wires fixed with iron staples down the four corners of the chimney; these four wires are connected at four points by similar wires running round the chimney, so that a very large meshed network covering the whole chimney is formed. Each wire has a separate earth, which is made by digging a pit and fixing a 6ft. length of 4in. iron pipe up the centre by stamping in coke all round. The No. 7 iron wire is then leaded into the top of the pipe.

The station is laid out to receive five Babcock and Wilcox boilers, each capable of evaporating 6,000lb. of water per hour, the working pressure being 200lb. per square inch; one heater of the usual vertical type, capable of supplying water at 212° F. for four boilers, in which the feed-water is made to trickle down a number of tubes about 1in. in diameter, which are heated from the outside by contact with the exhaust steam; five Willans triple expansion engines of 200 indicated horse-power, each of which is coupled direct to a 100-unit Elwell-Parker alternator; two Willans engines coupled direct to exciters. The boilers all face towards the yard, beneath which coal bunkers are formed, so that the coal is dumped just where it is wanted without further handling.

Mr. Gordon has taken great care to avoid risk of having to shut down lights from an accident to the steam piping. The main steam pipe runs down one side of the boiler-house, passes completely round the generating-room, and returns along the far ends of the boilers. The two ends of the loop thus formed are connected by cross pipes which pass over each boiler, and into which the boilers deliver their steam. It will be seen that, with this arrangement, by means of stop-valves either side of the loop can be shut off from the live steam and the engines

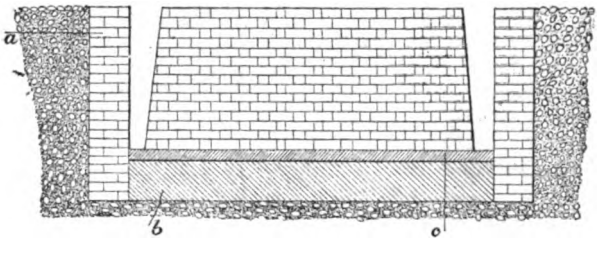


FIG. 1.—Arrangement employed at the Rathbone-place Station to decrease vibration.

fed by means of the other side. Again, if an accident happens to a section of pipe between two engines, this section can be cut out by means of stop-valves, and the engines on one side fed by one side of the loop, and those on the other side of the disabled section can be fed by the other side of the loop. Thus joints can be made, or even a new length of steam pipe inserted, while the system is under steam. The pipes are of wrought iron 9in. in diameter, the flanges are pressed from armour plate by hydraulic machinery, and are screwed and brazed on to the ends of the pipes. All bends are of copper, and the whole of the piping is suspended from the ceiling by iron hangers. Noke's centrifugal separators are employed in the branch connections to each engine.

Another feature of this station is an arrangement to avoid the transmission of vibration either to the station buildings or to other buildings in the neighbourhood. A pit is dug out, of the required depth, the sides of which are lined with four retaining walls; 12in. of concrete is now put in to form a sub-base, on the top of which is laid hair-felt to a thickness of about 2in. The brick or stone base upon which the machinery is bolted, is built upon the hair-felt, a space being left all round between it and the retaining walls. Fig. 1 shows a section of this arrangement—*a* is the retaining wall, *b* is the sub-base, *c* is the hair-felt.

Fig. 2 shows an elevation of an engine and dynamo. The engines are of the Willians type, triple expansion, with the three cylinders ranged one above the other. The cylinders are all single acting, and the cross-head and crank bearings are always in thrust. The cranks are at right angles; they are enclosed, and lubrication is effected by splashing in the now

Digitized by Google

common way. The engines run at 350 revolutions per minute, and normally develop 200 indicated horse-power, with 200lb. initial pressure per square inch. The coupling between engine and dynamo is an ordinary form, and has been rendered sufficiently elastic by the introduction of $\frac{1}{16}$in. thickness of rubber between the two discs.

The dynamo is constructed with stationary armature coils, which are arranged flatwise upon the inner surface of a cylinder, inside of which the field-magnets revolve. The magnets are 5ft. 6in. in diameter, and 1ft. 6in. broad over the polar surfaces; there are 36 poles, and the winding is about 5in. long, and of equal depth to the thickness of the iron core. The armature coils are wound upon wood cores of equal breadth and length to the magnet poles, and each contain 24 turns of copper ribbon $\frac{1}{2}$in. wide. The effective surface of the cylinder occupied by wire is approximately double that occupied by the wood cores. The cylinder in which the armature coils are fixed is formed of laminated iron, the laminæ being held together by cast-iron framework, and lagged over all. The air space, including the depth of the coil, is about $\frac{5}{8}$in. At a speed of 350 revolutions per minute, the machines give 2,000 volts E.M.F. and 230 ∿ per second. The bearing supports are cast with chambers for the circulation of water in case of emergency. The exciting dynamos are direct driven by similar engines to those driving the main dynamos. They run at 470 revolutions per minute, and give 200 amperes at 140 volts E.M.F. The

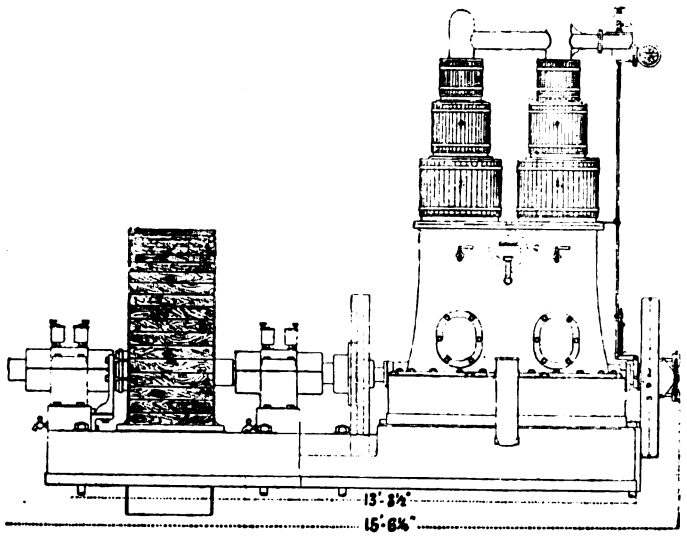


Fig. 2.—Willans Engine coupled direct to Elwell-Parker Alternator.

magnets are compound-wound to give a constant E.M.F. at the dynamo terminals, so that the connection or disconnection of the coils of a dynamo, or the adjustment of resistance in circuit, does not interfere with the adjustment of any other machines which may be running. Each dynamo takes about 40 amperes at 140 volts E.M.F. for its exciting coils. At present it has been found necessary to disconnect the lowest cylinders of the engines and run the exciting sets compound, as the load is so light that a partial vacuum formed in the cylinders and took the thrust off the cranks. It should be mentioned that only two of the five generating sets are as yet in position, and the exciters when at work are only half-loaded. As already indicated, regulation is effected by inserting resistance by hand into the field-magnet circuits according to the readings of a Cardew voltmeter, which is connected across two armature coils, and therefore reads $\frac{1}{18}$th of the full E.M.F., or nominally about 57 volts. The main ammeters are of Evershed's patent, made by W. T. Goolden and Co. The switches for the main circuits consist of 6in. square earthenware slabs or plates, with four projecting brass pins on one side, and a handle on the other. The pins are connected to form two pairs, and fit into four holes in the switch-board. When in position each pair of pins and its connecting piece forms a bridge-connection between the dynamo lead and the line. The switch—which is, of course, double-pole—therefore breaks the connection at four places simultaneously. The main-circuit fuses are enclosed in perforated earthenware cases. The fuse itself consists of a wire about 12in. long, which is connected between two plugs with earthenware handles. Arrangements have been made for observing, by means of a lamp connected to two converters on different dynamos, when the dynamos are in step, with a view to coupling in parallel; but Mr. Tomlinson, to whom we are indebted for most of these particulars, informed us that no attempt had as yet been made to run the alternators in parallel.

ON THE DISCHARGE OF ELECTRIFICATION BY FLAMES.*

BY A. M. WORTHINGTON.

It is well known that an ebonite or glass rod that has been electrified by rubbing is immediately and completely discharged by passing it either through or over a flame—for example, of a Bunsen burner. It is, I think, less well known, though the observation seems to have been made by Priestley,† that the discharge takes place with apparently equal rapidity if the rod be held at the side of, or even below, the flame at a distance of, say, 5cm. This is the case whether the Bunsen burner be insulated or not, and it is equally true of a candle flame. A red-hot piece of iron or copper discharges a rubbed rod that is held very near it, whether above, below, or at the side. If the rubbed rod be a very thick one—say of 3cm. diameter—it is not at once discharged on the side remote from the flame. If held at a distance of, say, 8cm. from the flame, a rubbed rod of 8 or 10mm. in diameter is less rapidly discharged than at the nearer distance, but is still discharged in a few seconds; but the rate of discharge diminishes very rapidly as the distance from the flame is increased.

If a plate of metal, insulated or uninsulated, or a piece of wire gauze of even coarse texture, be held with one side close to the flame and then a charged rod be brought up to the other side of the plate, no discharge takes place. A plate of glass or ebonite held in the same way between the flame and the rod equally prevents discharge. But when the charged rod and glass plate are withdrawn together from the neighbourhood of the flame, then the glass plate is found to be charged on the side nearest the flame with a charge of opposite sign to that of the charge on the rod.

The above experimental facts, which will be more or less familiar to physicists, are here cited in order that the significance may be perceived of the experiment that will next be described. Being under the impression, which I fancy is pretty general, that the flame and the surrounding air constituted a sort of conductor which removed the charge of the rod, as it were, by licking its surface, or, perhaps, as Van Rees‡ suggested, by throwing off, under the influence of the charged rod, finite portions of itself charged inductively with the opposite electrification, I made the experiment of surrounding the rod by a strong blast of air from a foot blow-pipe, expecting thereby to prevent the discharge by blowing away the conductive air before it reached the surface of the rod; but I found that the interposed blast of air, however violent, was quite without influence on the discharge, which took place across it with perfect facility when the flame was approached. It should be mentioned that the blast alone without the flame was quite incompetent to discharge the rod.

This observation makes it, I think, quite clear that the discharge is effected, not by the flame or mass of air round it acting as a whole, but by a molecular action, the velocity of propagation of which is very great compared with the velocity of the air in the blast. All the phenomena above mentioned, and others to which I shall shortly allude, appear to be explainable as follows, and, so far as I can see, in no other way. The

* Appendix to the Fourth Report of the British Association Committee on Electrolysis, presented at the Newcastle Meeting, September, 1889.

† An historical *résumé* of early observations on the electrical properties of flames is given in the Paper of Peter Riess, "Ueber die Elektrischen Eigenschaften brennender Körper, *Pogg. Ann.*, Vol. LXI., 1884.

‡ *Pogg. Ann.*, Vol. LXXIV., p. 379, 1849.

Digitized by Google

flame contains a large number of dissociated atoms, each with positive or negative atomic charges. A charged body, such as the rod, attracts towards itself those of opposite sign and repels those of the same sign, and under this directive influence an electrolytic action is propagated across the intervening air, the discharge being effected by the liberation of free atoms on the surface of the body. When a glass or ebonite plate is interposed this liberation takes place on the surface nearest the flame, and the plate is thereby charged. The shortness of the mean free path of molecules, and presumably also of atoms in the air at atmospheric pressure, and the incompetence, so far as I can observe, of even the most violent interposed blast of air to affect the discharge, seems to preclude the supposition that the free atoms which reach the rod are those which were originally present in the flame.

The flow in the opposite direction of atoms bearing charges of the same sign as that of the rod was put in evidence by the experiment of placing a glass or ebonite plate near to an insulated flame, and then bringing up a charged rod to the opposite side of the flame, when the plate was found to receive a charge of the same sign as that of the rod. Care must be taken to withdraw the plate as the rod is approached, otherwise it also will be discharged. A variation of this experiment is to make the like charge flow on to and charge an electroscope by means of an interposed insulated flame. For some experiments of this kind a metallic conductor connected with an electrical machine by which the charge may be maintained was found more convenient than the charged rod.

When a charged insulated body is discharged by the proximity of an insulated flame, it is not at once obvious how the equal and opposite charge on the walls of the room in which the experiment is made has been neutralised. I imagine that this must be effected by an electrolytic discharge through the air between the flame and the walls, originating in the excess of atoms charged similarly to the body, which are left over when the charge on the body is neutralised, and on which the lines of force proceeding inwards from the walls of the room now terminate. Thus the discharge involves the shifting of the ends of these lines of force from the original rigid body on to atoms which are free to move under the directive stress.

If this explanation of the discharge by a flame is correct, it should follow that discharge should be facilitated whenever free atoms are present, and I found on trial that when a rubbed ebonite rod was placed transversely in the path of the spark discharge, between the terminals of a Wimshurst machine, it lost a large amount of its charge at the passage of each spark, and was soon completely discharged. This appears to be a special instance of the phenomenon brought into notice by Dr. Schuster of a small electromotive force producing a current when the electrolyte has been broken down by a greater electromotive force.

For investigation of the temperature at which a piece of hot metal begins to act like a flame in producing discharge, a storage cell was insulated and connected with an electroscope, and charged statically; the terminals were then joined by a strip of thin platinum foil, whose length could be varied at will by means of insulating handles. The strip when shortened became more and more heated by the increased current, but only when a red heat was reached did I observe that the statical charge of the cell began to escape. This would seem to show that (in daylight at any rate) dissociated atoms are not found at the surface of the metal at a temperature below that of a red heat. The rate of escape of charge was much increased by holding an earth-connected conductor near to the red-hot platinum. This would increase the density of charge at the surface of the platinum, and therefore the electric force at the surface, *i.e.*, the directive force on the free atoms.

By hanging side by side, in a large Bunsen flame, a sheet of copper and a sheet of platinum, which were connected outside the flame by a wire having in circuit a galvanometer of about 200 ohms resistance, a feeble current of about 2×10^{-6} amperes was obtained, the flame appearing to act as an electrolyte of very high resistance, through which the current passed from the more oxidisable copper to the less oxidisable platinum. When, however, two sheets of platinum were hung in the flame so that one just touched the outside, while the other bisected the flame, a current of about the same magnitude was obtained, and in either direction at will, according to the relative positions of the plates in the flames, and the observation of Messrs. Elster and Geitel was confirmed, that the outer mantle of the flame is at a higher potential than the interior of the flame. The effect of this seemed to over-ride and obscure any effect due to the difference of the material of the two plates. I have not been able to obtain any more direct experimental evidence that there is an excess of positive atoms on the outside, and of negative on the inside of the flame.

The only experiment mentioned in this Paper that I can suppose to be new is that of the air-blast; but in the light of this, the significance of the other experiments cited seems considerably changed, and the inference that a charge of either sign, indistinguishable from the charges that are produced by friction, may be obtained on a non-conductor in air, by the liberation of free atoms on its surface, is not at present so familiar that any excuse seems required for emphasising it.

NOTE.—Professor Poynting has suggested to me, since the above was written, that the charges of the dissociated atoms might be so great and their masses so small, that the acceleration communicated under the electric stress would suffice to enable the original atoms present in the flame to traverse the air-blast.

THE PASSAGE OF ELECTRICITY THROUGH GASES.*

BY ARTHUR SCHUSTER, F.R.S.

The author has during the last two years investigated the distribution of potential in the neighbourhood of the negative pole of a discharge of electricity through rarefied gases. Knowing the rate of fall of potential, it can be determined whether there is any bodily electrification in any part of the negative glow. It was found that the negative pole is surrounded by an atmosphere of positively electrified gaseous particles extending to the outer edge of the so-called dark space. According to the author's views, this atmosphere corresponds to the polarised layer adjoining the negative electrode in an electrolyte. The cause of the sudden difference in luminosity between the dark space and the negative glow has also been investigated, and it has been found that the negative particles projected from the negative electrode pass unhindered through the dark space, while their velocity is quickly reduced in the glow proper, the translatory energy being thus changed into energy of vibration. Assuming that each particle carries the same amount of electricity as in an electrolyte, the velocity of the ions has been calculated from the behaviour of the discharge in the magnetic field. All details regarding the experiments will shortly be communicated to the Royal Society.

TRANSFORMERS.†

BY HARRIS J. RYAN.

It was with a view of obtaining so far as possible a clear understanding of all phenomena that take place in the commercial transformer, that the work producing the results here set forth was undertaken. It has not been possible at this time to prepare a Paper as complete as has been been desired, and we trust that in the near future we may add more data to that which is here presented. At the outset it should be said that the results of the experiments that are here presented were wrought out jointly by Mr. Ernest Merritt, of the Department of Physics, Cornell University, and the writer. What we had in mind in the work was an accurate determination of the exact performance of the commercial transformer whereby one should be able to derive results and data that should enable all phases of the performances of transformers to be understood clearly, and that should show the requisite principle of proper design.

It may be well to state briefly the general method we employed. A single ten-light transformer that had been made and

* Paper read before the British Association, in Section A, Newcastle-on-Tyne, September, 1889.

† A Paper read before the American Institute of Electrical Engineers, New York, December 17, 1889.

Digitized by Google

supplied for commercial purposes for incandescent lighting with 1,000 volts in the primary and 50 volts in the secondary was selected as a sample for investigation. It probably represented fairly well the average commercial performance of transformers, and might therefore be said to embody, to a certain extent at least, proportions that have proven by experience and experiment to be best for the particular purpose for which it is supplied. This transformer was operated under the same impressed E.M.F. supplied from the electric lighting plant in which it had been used for supplying incandescent lamps commercially. It was operated with its secondary open and the same closed through one lamp, five lamps, and ten lamps, and under these several conditions the exact instantaneous values of the ever-varying, primary-impressed E.M.F., primary current, and the E.M.F. at the terminals of the secondary, were observed. Again, under these several conditions the square roots of the mean squares of the above values and of the secondary current were also observed. Then with these observations, the dimensions, and the details of the construction of the transformer, many of the facts and performances that the engineer is concerned with are brought to light.

Naturally the first thing to be considered is the electrical measurements and how they were made. A point on the armature of an alternator always passes a fixed point in its circumference at a time corresponding to a definite value of the varying E.M.F. and current, alike, with regard to these quantities in the primary feeders, transformer, primary or secondary, &c., so long as the conditions remain constant. In our experiments we were only concerned with the values of the E.M.F. impressed at the terminals of the primary, the primary current, and the secondary E M.F. ; then, by changing the position of the fixed point relative to the machine, the rotating point of reference in the armature would pass the new position of the fixed point at correspondingly different values for the primary E.M.F., primary current, and secondary E.M.F., with respect to themselves and the position of the armature.

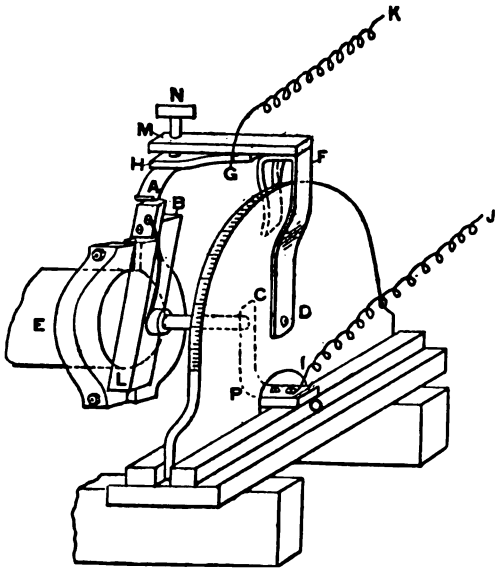


FIG. 1

In Fig. 1, B L is a prism of hard rubber bearing a projecting strip of brass, B, that, on its upper side, is filed to a dull edge. This edge is taken as a fixed point on the armature. An arm, F D, is arranged to rotate about D as a centre, a point that is in line with the axis of rotation of the armature. A semi-circular board of hard wood, attached rigidly to the dynamo frame, serves both as a support for this arm and a circumferential scale whereby the position of the arm may be observed relatively to the machine. The arm is made of brass, and given the form shown in the figure. It was bent into a U-shape at the top so as to pinch the board, and thus remained fixed in any position desired. At the top of this arm is mounted a bar of hard rubber projecting toward the dynamo parallel to the armature axis. On its underside, fastened at G, is a brass strip ; a tongue, H A, of spring brass is attached at the end, and at right angles to the brass strip H G, as shown. The position of this part of the apparatus is carefully adjusted, so that the point about which the arm rotates is in line with the axis of rotation of the armature, and the sharply upward curved end of the tongue H A, just over the edge of the brass strip at B. Then when the armature is rotated the strip H G may be sprung inward radially by turning the thumb screw N until the tip of the tongue A is heard to just lightly touch the edge at B as it passes. The arm may then be adjusted by hand so that the tongue will touch the fixed edge on the armature at any desired phase of the primary E.M.F., primary current, or secondary E.M.F. and current. Coaxially with the armature a small brass rod is mounted on the bar of hard rubber, B L. It is connected metallically to B by means of a wire. At O on the frame work supporting the semi-circular board, &c., is mounted another piece of hard rubber, insulating and supporting the thin metallic strip P C that bears against the above brass rod. G and I then are the terminals of this commutating apparatus.

In Fig. 2, E F is a non-inductive resistance in series with the primary of the transformer which is at work. At A is the apparatus described in Fig. 1, and E is an electrometer reading through a wide range.

The terminals of the above non-inductive resistance and those of the electrometer are connected together through the commutating apparatus at A. Then it must be evident that the electrometer will become charged with a difference of potential equal to that existing between the terminals of the non-inductive resistance at the instant that the fixed edge on the armature passes the tip of the tongue in the apparatus at A. By reading the indications of the electrometer, therefore, and knowing the value of the non-inductive resistance E F, the value of the primary current corresponding to the particular phase due to the position of the arm in the apparatus at A becomes known. In a similar manner the primary and secondary E.M.F. are observed by changing the connections accordingly at G_1, G_2, G_3, G_4. Then the arm is rotated to another position, corresponding to a different phase, and the corresponding values of E.M.F. and current again observed as before. In this manner we proceed at different intervals, sufficiently near, so that a curve may be determined by the values thus observed at the several intervals, so that the values of the E.M.F.s or currents, shall be accurately known at all times throughout a complete period.

A few words with regard to the electrometer at E are not out of place here. It is the form that the writer devised especially for this and similar purposes. The essential features for an electrometer for these purposes are that it shall have the widest possible range through which it will read with accuracy. Its indications must be unvaried by the absolute potential to which it is subjected as a whole. Its law must be perfectly definite, and it is also

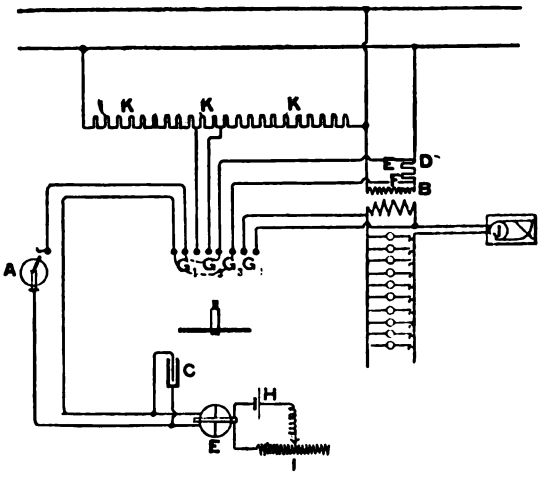


FIG. 2.

desirable that its constant be unchanging. This instrument consists essentially of cylindrical electrometer needle and quadrants. To the upper side of the electrometer needle is attached a magnetised steel mirror that acts as a magnet and as a mirror for observing the position of the same. The needle is hung by a single silk fibre from a hook in the top of the case. Metallic contact from the needle to the case is made by means of a platinum wire ·0002in. in diameter. This wire is readily provided in the desired form by using the platinum-cored silver wire that is supplied by makers of surveying apparatus. It is cut to the desired length, and hooks bent into shape at its terminals. By immersing all of it but the hooked terminals in nitric acid, the silver is dissolved away, leaving the fine platinum core terminated by the two silver hooks. One end of this platinum wire thus prepared is linked into a hook into the top of the electrometer case, and the other end into a small ring formed by a twist of the aluminum wire that surrounds the mirror. The electrometer case is circular, and the above needle and quadrants are arranged so that the magnetised mirror is at the centre of the case and the needle and quadrants below it. About the case is wound a coil of rather fine insulated copper wire. The magnetised mirror and thin coil then, when the latter is in the magnetic meridian, constitute an arrangement similar to that of a tangent galvanometer. In the electrometer, the needle, case, and one set of quadrants are connected together, and form one terminal,

Digitized by Google

and the other set of quadrants, being connected together, form the other terminal of the instrument, in the manner set forth in the diagram. Thus, then, when the electrometer terminals are subjected to a difference of potential, the needle is acted upon by a couple brought about by the electrostatic forces, and is deflected from its position of equilibrium. Current from a gravity cell in circuit with a suitable rheostat is sent through the coil on the electrometer in such a direction that the needle is brought towards its zero position by the action of the coil carrying the current on the magnetised mirror. The current is then further adjusted till the needle stands balanced at zero under the mutual action of the electrostatic and the electro-magnetic forces. Under such circumstances, then, the difference of potential is proportional to the square root of the current.

If we can, as was the case when the measurements here presented were made, consider the E.M.F. of our cell constant, the difference of potential is likewise proportional to the square root of the reciprocal of the total resistance in circuit with the cell. Parallel readings, taken with a standard voltmeter throughout a range varying from 3 to 600 volts, gave identical results, showing no deviation from the above law, and an unvarying constant. On account of the metallic case and its connection to the rest of the apparatus, the indications of the electrometer are, so far as could be observed, entirely independent of the absolute potential to which it is subjected as a whole. In Fig. 2, when contact was made at A, and the electrometer charged to the potential difference to which its terminals were then subjected, it was found that considerable of the charge was dissipated by leakage during the course of a revolution of the armature, no matter how good the insulation of the apparatus was. A one-half microfarad mica condenser was then placed in multiple arc with the terminals of the electrometer at C. Then, after a few revolutions of the armature, the condenser became charged to precisely the same difference of potential existing at the terminals of the electrometer D B, as shown in Fig. 2, when the rotating edge on the armature passed the tip of the tongue on the arm at A. Under these circumstances the leakage that occurred was entirely unobservable as compared with the charge in the condenser during the course of time required for the armature to make many revolutions. Thus arranged, then, the electrometer would give accurate readings of the primary and secondary E.M.F.s, and primary current corresponding to the connection of the terminals and the position of the arm A. Again, the square root of the mean square of any of these values could at any time be read from the electrometer by short-circuiting the apparatus at A, and cutting out the condenser at C. For the purpose of obtaining the curve of impressed E.M.F. and the $\sqrt{\text{mean}^2}$ of the same, 22 50-volt lamps were put in series across the primary circuit. The $\sqrt{\text{mean}^2}$ of the impressed E.M.F. in the primary was then obtained by reading by means of the electrometer with the condenser cut out and the commutating apparatus short-circuited, the $\sqrt{\text{mean}^2}$ difference of potential existing between each set of two lamps. In this way 11 readings were obtained, the sum of which was the total impressed E.M.F. This served as a calibration of the non-inductive resistance formed by the lamps. At the same time that these observations were made, two lamps were determined upon to be used in all subsequent observations on the total E.M.F. The above observations served, then, as a calibration for the indications of the two lamps thus to be used. For the constant obtained by the ratio of the above total E.M.F., to the E.M.F. of these lamps taken at the same time, always served to deduce the total $\sqrt{\text{mean}^2}$, or any particular value corresponding to a particular phase of the impressed primary E.M.F. when the same had been observed with regard to the two lamps in the group thus set apart. In this way we avoided the direct measurements of the total impressed E.M.F. Two 50-volt lamps, E and F, wereplaced in series with the primary as a non-inductive resistance, and, as previously stated, the $\sqrt{\text{mean}^2}$, and the values corresponding to any particular phase of the fall of potential through these lamps, were observed. This gave a measure of the $\sqrt{\text{mean}^2}$, or any particular value corresponding to a particular phase of the primary current, when the resistance of these lamps was known at the temperature to which they were brought by the current. A curve of resistance corresponding to the range of currents through which we used these lamps was determined carefully by Mr. Merritt at the Cornell Magnetic Observatory. In series with the secondary circuit was placed a gravity ammeter containing a few small turns, and correct in its adjustment. It indicated the $\sqrt{\text{mean}^2}$ in the same way that an electro-dynamometer would have done. The observing of the various values of the secondary E.M.F. required no special arrangement: this was done direct in all cases. Since the secondary was always at work on a circuit possessing almost no inductance, no determinations of the curve of secondary circuits were made, for it would be found to be so nearly in unison with the secondary E.M.F., and possees all the characteristic variations of the same. The $\sqrt{\text{mean}^2}$ of its value was always known from the indications of the ammeter. As a load for the transformer, 10 16 candle-power 50-volt lamps were provided that could be turned on and off as desired, and they were at an average distance from the transformers of not more than 5ft.

G_1, G_2, G_3, G_4 represent, in Fig. 2, the various terminals conveniently arranged on a switch-board for ready adjustment for any desired set of connections. The adjustable resistance at I consisted of a plug resistance box enabling one to get any number of ohms in circuit from 100,000 down. It was very conveniently arranged, but a suitable slide rheostat and a damped magnet on the electrometer needle would have facilitated greatly the rapidity with which observations could be taken. The mode of procedure was to set the brush at some suitable point of starting out; then, corresponding to this point, readings of the instantaneous values of the primary E.M.F. were made. When lamps were turned on in the secondary, the ammeter in that circuit was also read. The brush was then moved forward to a new position, and the above readings repeated. This was continued until we had gone over a complete period of two alternations; then the $\sqrt{\text{mean}^2}$ readings of the primary and secondary E.M.F.s and primary current were made. To do this required a period of time covering usually not more than two and a-half hours. Careful observations were made which showed that the insertion of one, two, or three lamps in the primary circuit *did not perceptibly change the relation* of the primary E.M.F. and current and secondary E.M.F. The indications of the ammeter gave data for correcting for variations of the speed of the dynamo, which throughout were not great.

The following data should be given with regard to the transformer that was used by us:—

No. of turns in the primary circuit coil	675
No. of turns in the secondary coil.....	35
Resistance of the primary	21·8 ohms.
Resistance of the secondary	·04 ohms.

The iron discs of the magnetic circuit of the transformer were made ½ millimetre in thickness, and its surface merely oxidised so that no special insulating material was provided between the laminations. The total volume of laminated iron used in the transformer was 2,050 cubic centimetres. The mean cross-section of the magnetic circuit was 63·3 square centimetres, and the mean length of the magnetic circuit 30·8 centimetres.

(To be continued.)

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To night) FRIDAY, January 10th.

INSTITUTION OF CIVIL ENGINEERS.

7.30 p.m. Students' Meeting. Paper to be read, "The Irrigation Works on the Cauvery Delta." By ALFRED CHATTERTON, B.Sc.

MONDAY, January 13th.

LONDON INSTITUTION.

5 p.m. Lecture: "University Education in London." By Sir PHILIP MAGNUS, B.Sc., B.A.

TUESDAY, January 14th.

ROYAL VICTORIA HALL.

8:30 p.m. Lecture: "The Bottom of the Sea." By D. P. H. CARPENTER.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be read, "Recent Dock Extensions at Liverpool." By GEORGE FOSBERY LYSTER, M.I.C.E.

WEDNESDAY, January 15th.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Adjourned discussion on SIR ROBERT RAWLINSON'S Paper on "London Sewerage and Sewage."

THURSDAY, January 16th.

LONDON INSTITUTION.

6 p.m. Lecture: "The Sugar Islands of the West." By D. MORRIS, M.A.

FRIDAY, January 17th.

SOCIETY OF ARTS.

5 p.m. Indian Section. "The India Office Records." By F. C. DANVERS.

*** Particulars of meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.

Digitized by Google

The Electrician.

Published every Friday. Price Fourpence; Post Free, Fourpence Halfpenny
Editorial, Publishing and Printing Offices:

No. 1, SALISBURY COURT, FLEET STREET, LONDON, E.C.

Telephone No. 2714. *Telegrams:* "ELECTRICIAN NEWSPAPER, LONDON."

All Communications to be addressed to "THE ELECTRICIAN," *1, Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN."

All letters intended for insertion in "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. Subscribers should receive their copies by the first post on Friday morning.*

"THE ELECTRICIAN" *is on sale at the railway bookstalls throughout the United Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices as above.*

SPECIAL NOTICE.

Owing to the increase in the number of pages of "THE ELECTRICIAN," in order to partly cover the increased postage, we have been compelled to revise the rates for Foreign Subscriptions, which are now as follows:—

	3 months.	6 months.	12 months
For Foreign Parts and Colonies:—	s. d.	s. d.	s. d.
Within Postal Union	6 6	12 6	24 0
Aden, Borneo, Ceylon, China, India, Japan, Java, Labuan, Mozambique, New Caledonia, Persia, Philippine Islands, Siam, Transvaal, and Zanzibar	7 6	14 6	28 0
The rates for the United Kingdom remain as follows:—	5 0	10 0	19 6

TO ADVERTISERS.

"THE ELECTRICIAN" *offers exceptional advantages to Advertisers.* **It has the largest circulation of any English Electrical paper, and circulates all over the World.**

Particulars relating to Advertisements will be promptly forwarded on application to the office.

TRADE ADVERTISEMENTS *intended for the current issue must be handed in not later than First Post on Thursday morning.*

SMALL PREPAID ADVERTISEMENTS *(for Rates see page xiii.) are accepted up to 4:30 p.m. on Thursday.*

TECHNICAL PRINTING.

"THE ELECTRICIAN" PRINTING AND PUBLISHING COMPANY (LIMITED) *beg to inform Electricians, Electric Light Engineers, &c., that they make a specialty of Technical Printing, and have a Staff thoroughly acquainted with Electro-Technology. They can, therefore, promise Accuracy and Despatch in the Printing of Electrical Catalogues and Electro-Technical Literature generally.*

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.

Royal 8vo.

Early in each year is issued "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK. *The* DIRECTORY *was established in 1883, and the 1889 Edition consisted of more than 600 pages of printed matter. The names and addresses of all persons engaged in the Electrical Industries may be relied upon as accurate. Useful Tables and Electrical Formulæ, and information specially compiled for this work are given, together with popularly-written Biographical Notices of the leading Electricians, Electrical Engineers, &c., accompanied in many cases by Portraits.*

The issue for 1890, which will be still further enlarged and improved, is in active preparation. New Names and Addresses, Corrections, Advertisements, &c., should be forwarded at once to the Publishing Office, **1,** *Salisbury-court, Fleet-street, London, E.C.*

CONTENTS OF THE CURRENT NUMBER.

NOTES	231
Dr. John Hopkinson	236
The Rathbone Place Station of the Metropolitan Electric Supply Company. Illustrated	237
On the Discharge of Electrification by Flames. By A. M. Worthington	238
The Passage of Electricity Through Gases. By Arthur Schuster, F.R.S.	239
Transformers. By Harris J. Ryan. Illustrated	239
Meetings of Scientific Societies.	241
1889	242
OBITUARY—	
Stephen Joseph Perry	245
Charles Lever	245
The Institution of Electrical Engineers—Dr. John Hopkinson's Presidential Address.	245
Tests of the New Sprague Street Railway Motor. By Dr. Louis Bell	247
Report to the St. Pancras Vestry on Electric Lighting. By Professor H. Robinson, M.I.C.E.	248
American Notes	250
Scandinavian Notes	250
CORRESPONDENCE—	
The House-to-House Station at West Brompton.—Chas. J. Hall	251
LEGAL INTELLIGENCE—	
Inland Revenue Department *v.* The Mines and General Telpher Company	251
The South of England Telephone Company	251
Trade Notes and Notices	251
PATENT RECORD	252
COMPANIES' MEETINGS, &c.—	
United River Plate Telephone Company (Limited)	252
New Companies Registered	253
City Notes, &c.	253
Companies' Share List	254

OUR SUPPLEMENT.

With this Issue of "The Electrician" is published a Steel Plate Portrait of Dr. JOHN HOPKINSON, the newly-elected President of the Institution of Electrical Engineers.

A limited number of copies have been mounted on India Paper, and for these early application must be made. Price 1s.; post free, on roller, 1s. 2d.

The Portrait, in a neat frame, will be supplied at 4s. 6d., post free, 5s. If mounted, 5s. 6d., post free, 6s.

"THE ELECTRICAL WORLD" OF NEW YORK.

"THE ELECTRICAL WORLD" OF NEW YORK *can be obtained from* "THE ELECTRICIAN" *Office, Salisbury-court, Fleet-street, London, E.C. The Rate of Subscription (payable in advance), is* **£1 1s.** *per annum. Single Copies* **price 6d. each; post free, 8d.**

1889.

Continuing this week our review of the work done during the past twelve months, we append a few more reports from the leading electrical firms. Early in the year 1889 the business of Messrs. Laing, Wharton, and Down was divided, and that portion of it which related more especially to the establishment of central stations, and the exploitation of the Thomson-Houston systems of electric lighting generally, became the particular care of the Laing, Wharton and Down Construction Syndicate (Limited). The following, amongst others, have been the installations carried out by the Syndicate, viz., extension at St. Pancras terminus of the Midland Railway, Deptford Central Station, Bradford Station (Midland Railway), the Railway Clearing House, Central Station plants at Exeter, Bath, and Weybridge, and extensions at Taunton, Waterford, and Reading, whilst successful temporary work has been done at the Birmingham Exhibition (for which a special gold medal was awarded), and the sea front at Portsmouth for the Naval Review. No better evidence can be given of the great increase in the operations of the firm than that their staff has been trebled within the year. An important feature of the business has been the acquirement of the European agency for okonite insulated wires and cables, which

Digitized by Google

obtained a gold medal at the Paris Exhibition. Nothing but time alone can fully substantiate the claims made for this material, but past experience in the United States leads to the belief that it will at least prove quite equal to the best of its competitors. The following are some of the more important installations carried out by Messrs. B. Verity and Sons during the year:—The Savoy Hotel, the largest private plant in the world; Sir John Pender's, at Foot's Cray; the Grand Hotel, Brighton; Exeter Hall, Strand; the City Liberal Club; Messrs. Coutts' Bank; the new Theatre Royal and several hotels and private houses at Exeter; several houses at Bath, and half-a-dozen Atlantic steamers. Some idea of the amount of work done by this firm may be gathered from the fact that during the last eleven months they have used on their own works over 24,000 incandescent lamps in some 110 separate installations, an average of over two installations per week. With regard to future business, this firm has several heavy contracts in hand, and are now engaged in erecting the machinery for the electric light at Mr. D'Oyly Carte's new theatre in Charing Cross-road, where the total capacity of the plant will be nearly three thousand lights. In addition to several large installations in the country, they are now erecting the machinery for an important installation at Buenos Ayres, and are carrying the entire work through, including the wiring both for electric lighting and electric bells, and the fittings, the latter being of the most elaborate character. The General Electric Company have during the year increased both their manufacturing premises as well as their warehouses and offices. The factory in Manchester now gives employment to over 300 men, the machinery throughout being of the latest type. In London, besides the increased sale of their standard articles, the demand for specialities, such as Dr. Aron's meters, Apostle carbons, &c., has been very great. The Manchester Edison-Swan Company have been very fully employed during 1889. In the early part of the year they completed a central station on the low-tension system at St. John's, Newfoundland, the Houses of Assembly, the Government House, and other buildings being lighted; they have also carried out numerous private installations, many of which were of large size. A tolerably accurate estimate of the spread of electric lighting in this district may be formed from the fact that during the past year this Company have supplied 40,000 incandescent lamps.

The Callender's Bitumen Company report that their work during 1889 has been very largely in connection with underground mains for electric lighting, the Company having carried out several large contracts, undertaking the excavation and all the operations consequent thereon, the construction of the protecting conduit, and the manufacture and laying complete of the cables themselves, with all service and other boxes, to form a complete distributing network. The most important of these contracts was at Liverpool, where they have laid a complete network throughout nearly the whole of the business quarter of the city for the Liverpool Electric Supply Company. Similar work has also been done for the Metropolitan Electric Supply Company, Messrs. A. and S. Gatti, the Chelsea Electricity Supply Company, and at Bath. This Company has also supplied the cables for central station work at Lynmouth and Lynton, Gothenburg (Sweden), La Plata, Ensenada, Rosario, Buenos Ayres, and has been very busy supplying cables for the navy. The Telegraph Manufacturing Company report that the year has been an extremely busy one, especially the last six months, during which the output has been doubled, all departments having been fully occupied. The Phosphor Bronze Company report extensions of works and large orders.

Messrs. Willans and Robinson report that the work of the year, though of course greatly hampered by the destruction of the Company's machine shops by fire in November, 1888, has nevertheless much exceeded that of any previous year. Electric light work, by its importance and urgency, has claimed the greater part of the Company's attention, and the fact that the electric light engines made by this one firm (or put in hand for completion within a few weeks from now) are capable of indicating about *eighteen thousand horse-power*, shows not only how great a reputation the Willans engine and its system of direct-driving have obtained, but what a large amount of lighting work is now in progress in the country. Out of the 18,000 horse-power, about 4,000 is for ship lighting, but the balance is nearly all for land installations in England. Central stations, of course, account for the greater part of the work. Amongst the large customers in the year may be mentioned the English Admiralty, for whom at least sixty engines, mostly of large size, have been put in hand. In nearly all the large installations the engines and dynamos are divided into units of about 200 I.H.P., this appearing to be very convenient in practice, and corresponding with the standard H. size of the Willans engine. One or two engines of G.C. size (80 I.H.P. each) are usually included, so as to make it unnecessary to use the large engines with only a light load. Reports are beginning to come in of the coal consumption at various stations, and the results shown are of the most satisfactory kind, so that it may be considered doubtful, at least for the present, whether any advance beyond the 200 I.H.P. size is called for. Messrs. Willans and Robinson are, however, prepared to build engines indicating 550 I.H.P., at 280 revolutions per minute, should heavy central station work give rise to any such demand.

The year 1889 has not produced anything very novel in dynamos. The process of settling down with regard to designs which has been noticeable for the last two or three years has continued, and there may be said to be almost a complete weeding out of forms of machines that presented peculiar features. In direct-current machines drum armatures have to a certain extent replaced armatures with "Gramme" windings, and the field-magnets have shown a disposition to become more and more of the simple single horseshoe type, although it has been found that this type is somewhat heavier than that with double horseshoes or consequent poles. For some purposes the ring winding will no doubt always be adhered to. It is usually much easier to repair a faulty coil in such an armature than in the case of a drum winding, but this does not apply where the drum winding has the single conductor form. It is to be noted, however, that while the use of the simple drum machine has been increasing in this country, the movement on the Continent, and especially in Germany, has been, for large sizes of machines, in the direction of multipolar ring machines. English electrical engineers must not lose sight of this fact, for on the Continent direct-current dynamos have had to be made for much larger output than in England, and the difficulties experienced with simple two-pole machines of large size have been sufficient to show that such machines are not always the most suitable. There have been rumours of trials made with disc machines having some arrangement of radial conductors moving between poles of opposite sign, and without iron cores in the armatures. Mr. Crompton, for instance, is understood to be experimenting with the "Fritsche" dynamo, which is of this type, and which in its original form had iron armature conductors. But it remains to be seen whether this will give good results. The problem of making such machines practicable has always attracted the attention of electricians, but so far without any very good results. In direct-current motors the same process of settling down which we have observed with regard to dynamo has taken place, as of course follows from the fact that mos makers now recognise that the distinctions in form and propor-

Digitized by Google

tions between motors and dynamos are of a very trifling character. In very small motors there is no development to chronicle. Very few such moters are made or called for in this country, but probably the extension of central station working will soon produce a demand.

Turning to alternate currents, we find little change in the apparatus, but a considerable improvement in the state of knowledge. At the end of last year there appeared to be a growing belief that the alternate-current machines of the future would in some way or other resemble direct-current drum machines so far as the armatures were concerned, and that the older type of disc armature was in process of disappearing. It has, however, been recognised in the course of the year that machines are better without iron in the armatures, and the structural difficulties which were supposed to render the use of iron necessary do not appear to have been encountered by Ferranti and Mordey, while the losses incidental to its use have been avoided by those designers. We look with interest to the year just started to find whether the tendency to displace iron is confirmed. We think that the last twelve months have also revealed the fact that for the large alternate-current distribution schemes now being undertaken it will be quite possible to use machines of moderate size instead of very large machines.

It was expected that 1889 would see the Deptford Works of the London Electric Supply Corporation in actual operation; but for this we must wait a little longer. On the successful completion and operation of this station very much more depends than the well-being of the company directly concerned. It is not too much to say, however, that many experienced and competent electrical engineers regard the Deptford scheme with very considerable anxiety. Its failure, or comparative failure, by weakening public confidence, would give a blow to the industry from which recovery would be slow, while its success would fully confirm the improved feeling with which schemes for electric lighting are now regarded. All who have the true interests of the industry at heart will wish Mr. Ferranti well out of any difficulties which may have arisen in connection with his gigantic scheme. With regard to alternate-current motors, progress is very slow, partly, no doubt, because the real demand for them has not become urgent. With the establishment of numerous central stations, however, we hope to see motors of this class largely in use. The principle of working, which has been termed the "reaction principle," and which was worked out almost simultaneously by Ferraris, Tesla, and Elihu Thomson, does not appear to have yet fully justified the expectations that were at one time formed with regard to it, and in this country, at any rate, we have seen no applications of the principle for actual motors, although it is in use for meters.

In the cable world there is but little to chronicle. In the early part of the year the Eastern Telegraph Company laid a cable 52 miles in length, from the Island of Perim to Obock, the French Government subsidising the undertaking. The Eastern Extension, Australasia, and China Telegraph Company have during the current year laid the new cable between Banjoewangie (Java) and Roebuck Bay (Western Australia), a length of 890 knots, and they have renewed the Saigon-Hongkong section to the extent of 260 miles. At home the transfer of the Anglo-Continental cables to the respective Governments, and the practical extinction of the old Submarine Telegraph Company, took place early in the year. Greater facilities and improved working have been gradually introduced, with the result that a large increase of traffic has accrued.

The great event of 1889, so far as the telephone is concerned, is, of course, the amalgamation in May last of the three leading companies, an amalgamation which has not so far resulted in the improvements and extensions which we were confidently assured would inevitably flow from the union of the United, National, and Lancashire and Cheshire Companies. The National Telephone Company, from which particulars have been obtained down to November 27, 1889, was working no fewer than 251 exchanges and 475 call offices. Its exchange lines numbered 21,011 and its private lines 4,702. The fact that nearly 200 of the company's centres are in telephonic connection is a remarkable testimony to its energy and enterprise. The South of England Telephone Company, which still remains outside the northern combination, now possesses 1,780 miles of wire, and has during the past year opened seven additional exchanges, making a total of 31. Its exchange subscribers have increased from 1,758 to 2,206, and its private wire renters from 465 to 549. The messages transmitted through the exchanges in November, 1888, averaged 9,900 per day: in the corresponding month of 1889 this number had increased to 12,600. Several trunk lines have been run, connecting up various local exchanges. The accounts published in June last showed an increase of £4,000 in the year's revenue compared with the previous year's report. The Western Counties and South Wales Telephone Company has now 39 exchanges, and had a total of 2,343 subscribers and trunk renters on December 14, 1889. The principal exchanges are—Bristol, with 451 subscribers; Plymouth, with 278; Bournemouth, 228; Portsmouth, 194; Torquay, 126; and Southampton, 105. On December 14, 1889, this company had 669 private lines distributed over 130 places in the company's territory, thus in many cases bringing the telephone into the most remote towns and villages, and for the greatest variety of purposes, from the farm and rural requirements of one part of the country to the mines and collieries of another. In the Bristol, Bath, Gloucester, and South Wales district, the most distant points connected by trunk lines are Bath to Llanelly, 142½ miles; and in Devonshire the most distant points are Plymouth to Dartmouth, 36 miles. In the South of England Bournemouth is connected with Poole, and Portsmouth with Southampton and Winchester. The trunks between Portsmouth and Bournemouth are almost completed. The most distant point will then be Poole to Portsmouth—58 miles. In all, the company have 373 miles of trunk routes already completed. The calls on these trunk lines for the month of November, 1889, were 18,157. In January a span of wire 800 yards in length was erected over the River Dart at a height of 288ft. above high-water mark. Silicium bronze wire, No. 17, was used, weighing 24lb. for the span. This span is believed to be the longest in England. The working has been perfect, notwithstanding two heavy gales which have occurred since its erection. The total wire mileage of the Northern District Company now amounts to 3,019, and its subscribers number 1,090. It is proposed shortly to extend lines from Newcastle to Hexham, Carlisle, and Morpeth; Durham to Stockton; Blyth to Alnwick; Alnwick to Berwick; Darlington to Northallerton. The last-named connection will give communication with the whole of the National Telephone Company's English system. During the year this company's exchange subscribers have increased by 315, and it is anticipated that a continued increase will take place as existing Post Office agreements expire. The number of calls has increased from 891,517 in 1888 to 1,723,184 in 1889.

The telephone record for the year 1889 has, it will thus be seen, been one of steady progress. When the time comes for a review of the achievements of 1890, we hope to be able to record that telephonic communication has been successfully established between London and Paris, a proposition which, we believe, is under the consideration of the Post Office.

Digitized by Google

OBITUARY.

STEPHEN JOSEPH PERRY.

Father Perry, whose untimely decease whilst engaged on the Eclipse Expedition it is our sad duty to chronicle, was one of the greatest authorities on terrestrial magnetism. He was not the first Jesuit who has taken an active part in magnetic or electrical researches. Since the days of Athanasius Kircher there have been many scientific Jesuits. Father Beccaria, at the close of the last century, did much to improve our knowledge of atmospheric electricity; and the late Father Secchi, though better known for his astronomical work, was also an accomplished electrician. When the British Association met at Montreal in 1884, Father Perry was one of the first arrivals, and it is needless to say that he received a warm welcome, and gave a capital lecture.

Father Perry was born in London in 1833, and, after studying at the Catholic colleges of Douay and Rome, entered the Society of Jesus in 1853. Between this latter date and 1860 he went through a special course of mathematics at Paris, and was appointed professor and director of the observatory at Stonyhurst College in 1860. The only occasions on which he has been absent from Stonyhurst for any length of time were for studying theology at St. Beuno's College (four years) and to take part in scientific expeditions. Among these expeditions we may mention the magnetic survey of France in 1868-9, the transits of Venus in 1874 and 1882, and the eclipses of 1886, 1887, and 1889 at the West Indies, Russia, and Salut Isles. He was elected Fellow of the Royal Society in 1874, and he belonged to several other learned societies. He commanded the respect of all who were acquainted with his personal character and his scientific work by his utter self-abnegation when there was work to be done, being always ready to volunteer regardless of the intense sufferings which the expeditions cost him.

CHARLES LEVER.

It is with great regret that we announce the sudden death on Sunday last, at his father's residence, of Mr. Charles Lever so well known as the inventor of many electrical appliances. Mr. Lever was born at Gorton, near Manchester, 15th February, 1862, and was educated chiefly at Southport and Bowden. In 1878 Mr. Lever began the study of electricity and magnetism; and in 1879 made two trips to America. On his first return to this country he wrote an article on "Telephonic Exchanges," published in the *Manchester Guardian* in the early part of 1878; also an article on Mr. Edison and his inventions in the *St. James's Magazine* of August 1879. About this time Mr. Lever invented his first electric lamp, which was perfected and patented in August, 1881. He took out several patents in this country—some of which were also patented abroad—for electric light apparatus, dynamos, and telephones.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

DR. JOHN HOPKINSON'S PRESIDENTIAL ADDRESS.

Magnetism.

As old as any part of electrical science is the knowledge that a needle or bar of steel which has been touched with a loadstone will point to the North. Long before the first experiments of Galvani and Volta the general properties of steel magnets had been observed—how like poles repelled each other, and unlike attracted each other; how the parts of a broken magnet were each complete magnets with a pair of poles. The general character of the earth's magnetism has long been known—that the earth behaves with regard to magnets as though it had two magnetic poles respectively near the rotative poles, and that these poles have a slow secular motion. For many years the earth's magnetism has been the subject of careful study by the most powerful minds. Gauss organised a staff of voluntary observers, and applied his unsurpassed powers of mathematical analysis to obtaining from their results all that could be learned.

The magnetism of iron ships is of so much importance in navigation that a good deal of the time of men of great power has been devoted to its study. It was *the* scientific study of Archibald Smith; and Airy and Thomson have added not a little to our practical knowledge of the disturbance of the compass by the iron of the ship. Sir W. Thomson, in addition to much valuable practical work on the compass, and experimental work on magnetism, has given the most complete and elegant mathematical theory of the subject. Of late years the development of the dynamo machine has directed attention to the magnetisation of iron from a different point of view, and a very great deal has been done by many workers to ascertain the facts regarding the magnetic properties of iron. The upshot of these many years of study by practical men interested in the mariners' compass or in dynamo machines by theoretical men interested in looking into the nature of things, is, that although we know a great many facts about magnetism, and a great deal about the relation of these facts to each other, we are as ignorant as ever we were as to any reason why the earth is a magnet, as to why its magnetic poles are in slow motion in relation to its substance, or as to why iron, nickel, and cobalt are magnetic, and nothing else, so far as we know, is to any practical extent. In most branches of science the more facts we know the more fully we recognise a continuity in virtue of which we see the same property running through all the various forms of matter. It is not so in magnetism; here the more we know the more remarkably exceptional does the property appear, the less chance does there seem to be of resolving it into anything else. It seems to me that I cannot better occupy the present occasion than by recalling your attention to, and inviting discussion of, some of those salient properties of magnetism as exhibited by iron, nickel, and cobalt—properties most of them very familiar, but properties which any theory of magnetism must reckon with and explain. We shall not touch on the great subject of the earth as a magnet—though much has been recently done, particularly by Rücker and Thorpe—but deal simply with magnetism as a property of these three bodies, and consider its natural history, and how it varies with the varying condition of the material.

To fix our ideas, let us consider, then, a ring of uniform section of any convenient area and diameter. Let us suppose this ring to be wound with copper wire, the convolutions being insulated. Over the copper wire let us suppose that a second wire is wound, also insulated, the coils of each wire being arranged as are the coils of any ordinary modern transformer. Let us suppose that the ends of the inner coil, which we will call the secondary coil, are connected to a ballistic galvanometer; and that the ends of the outer coil, called the primary, are connected, through a key for reversing the current, with a battery. If the current in the primary coil is reversed, the galvanometer needle is observed to receive a sudden or impulsive deflection, indicating that for a short time an electromotive force has been acting on the secondary coil. If the resistance of the secondary circuit is varied, the sudden deflection of the galvanometer needle varies inversely as the resistance. With constant resistance of the secondary circuit the deflection varies as the number of convolutions in the secondary circuit. If the ring upon which the coils of copper wire are wound is made of wood or glass—or, indeed, of 99 out of every 100 substances which could be proposed—we should find that for a given current in the primary coil the deflection of th galvanometer in the secondary circuit is substantially the same. The ring may be of copper, of gold, of wood, or glass—it may be solid or it may be hollow—it makes no difference in the deflection of the galvanometer. We find, further, that with the vast majority of substances the deflection of the galvanometer in the secondary circuit is proportional to the current in the primary circuit. If, however, the ring be of soft iron, we find that the conditions are enormously different. In the first place, the deflections of the galvanometer are very many times as great as if the ring were made of glass, or copper, or wood. In the second place, the deflections on the galvanometer in the secondary circuit are not proportional to the current in the primary circuit; but as the

Digitized by Google

current in the primary circuit is step by step increased, we find that the galvanometer deflections increase somewhat as is illustrated in the accompanying curve (Fig. 1), in which the abscissæ are proportional to the primary current, and the ordinates are proportional to the galvanometer deflections. You observe that as the primary current is increased the galvanometer deflection increases at first at a certain rate; as the primary current attains a certain value the rate at which the deflection increases therewith is rapidly increased, as shown in the upward turn in the curve. This rate of increase is maintained for a time, but only for a time. When the primary current attains a certain value the curve bends downward, indicating that the deflections of the galvanometer are now increasing less rapidly as the primary current is increased; if the primary current be still continually increased, the galvanometer deflections increase less and less rapidly.

Now, what I want to particularly impress upon you is the enormous difference which exists between soft iron on the one hand and ordinary substances on the other. On this diagram I have taken the galvanometer deflections to the same scale for iron, and for such substances as glass or wood. You see that the deflections in the case of glass or wood, to the same scale, are so small as to be absolutely inappreciable, whilst the deflection for iron at one point of the curve is something like 2,000 times as great as for non-magnetic substances. This extraordinary property is possessed by only two other substances besides iron—cobalt and nickel. On the same figure are curves showing on the same scale what would be the deflections for cobalt and nickel, taken from Prof. Rowlands's Paper.

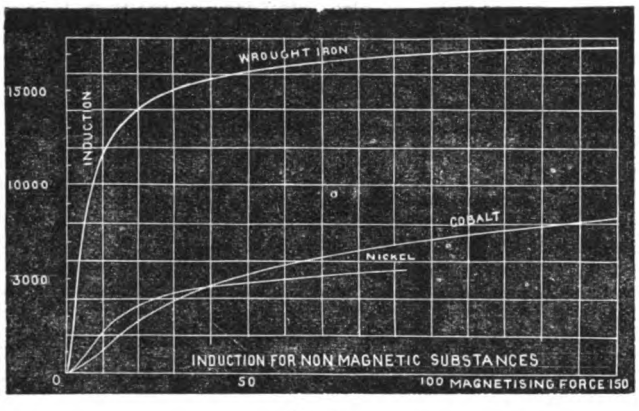


Fig. 1.

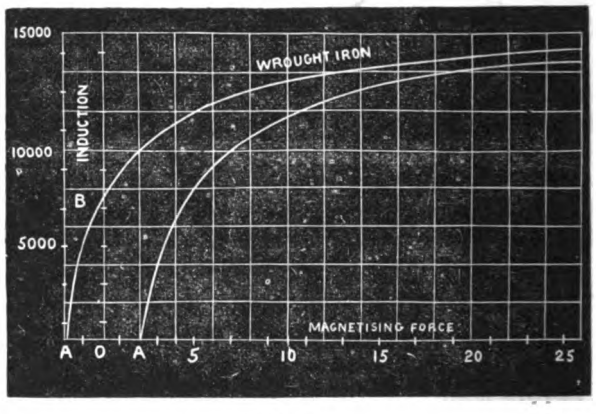


Fig. 2.

You observe that they show the same general characteristics as iron, but in a rather less degree. Still, it is obvious that these substances may be broadly classed with iron in contradistinction to the great mass of other bodies. On the other hand, diamagnetic bodies belong distinctly to the other class. If the deflection with a non-magnetic ring be unity, that with iron, as already stated, may be as much as 2,000; that with bismuth, the most powerful diamagnetic known, is 0·999825—a quantity differing very little from unity. Note, then, the first fact which any theory of magnetism has to explain is: Iron, nickel, and cobalt, all enormously magnetic; other substances practically non-magnetic. A second fact is: With most bodies the action of the primary current on the secondary circuit is strictly proportional to the primary current; with magnetic bodies it is by no means so.

You will observe that the ordinates in these curves, which are proportional to the kicks or elongations of the galvanometer, are called induction, and that the abscissæ are called magnetising force. Let us see a little more precisely what we mean by the terms, and what are the units of measurement taken. The elongation of the galvanometer measures an impulsive electromotive force—an electromotive force acting for a very short time. Charge a condenser to a known potential, and discharge it through the galvanometer: the needle of the galvanometer will swing aside through a number of divisions proportional to the quantity of electricity in the condenser—that is, to the capacity and the potential. From this we may calculate the quantity of electricity required to give a unit elongation. Multiply this by the actual resistance of the secondary circuit and we have the impulsive electromotive force in volts and seconds, which will, in the particular secondary circuit, give a unit elongation. We must multiply this by 10^8 to have it in absolute C.-G.-S. units. Now the induction is the impulsive electromotive force in absolute C.-G.-S. units divided by the number of secondary coils and by the area of section of the ring in square centimetres. The line integral of magnetising force is the current in the primary in absolute C.-G.-S. units—that is, one-tenth of the current in amperes—multiplied by 4π. The magnetising force is the line integral divided by the length of the line over which that line integral is distributed. This is, in truth, not exactly the same for all points of the section of the ring—an imperfection so far as it goes in the ring method of experiment. The absolute electro-magnetic C.-G.-S. units have been so chosen that if the ring be perfectly non-magnetic the induction is equal to the magnetising force. We may refer later to the permeability, as Sir W. Thomson calls it: it is the ratio of the induction to the magnetising force causing it, and is usually denoted by μ.

There is a further difference between the limited class of magnetic bodies and the great class which are non-magnetic. To show this, we may suppose our experiment with the ring to be varied in one or other of two or three different ways. To fix our ideas, let us suppose that the secondary coil is collected in one part of the ring, which, provided that the number of turns in the secondary is maintained the same, will make no difference in the result in the galvanometer. Let us suppose, further, that the ring is divided so that its parts may be plucked from together, and the secondary coil entirely withdrawn from the ring. If now the primary current have a certain value, and if the ring be plucked apart and the secondary coil withdrawn, we shall find that, whatever be the substance of which the ring is composed, the galvanometer deflection is one-half of what it would have been if the primary current had been reversed. I should perhaps say approximately one-half, as it is not quite strictly the case in some samples of steel, although, broadly speaking, it is one-half. This is natural enough, for the exciting cause is reduced from—let us call it a positive value, to nothing when the secondary coil is withdrawn; it is changed from a positive value to an equal and opposite negative value when the primary current is reversed. Now comes the third characteristic difference between the magnetic bodies and the non-magnetic. Suppose that, instead of plucking the ring apart when the current had a certain value, the current was raised to this value and then gradually diminished to nothing, and that then the ring was plucked apart and the secondary coil withdrawn. If the ring be non-magnetic, we find that there is no deflection of the galvanometer; but, on the other hand, if the ring be of iron we find a very large deflection, amounting, it may be, to 80 or 90 per cent. of the deflection caused by the withdrawal of the coil when the current had its full value. Whatever be the property that the passing of the primary current has imparted to the iron, it is clear that the iron retains a large part of this property after the

Digitized by Google

current has ceased. We may push the experiment a stage further. Suppose that the current in the primary is raised to a great value, and is then slowly diminished to a smaller value, and that the ring is opened and the secondary coil withdrawn. With most substances we find that the galvanometer deflection is precisely the same as if the current had been simply raised to its final value. It is not so with iron; the galvanometer deflection depends not alone upon the current at the moment of withdrawal, but on the current to which the ring has been previously subjected. We may then draw another curve (Fig. 2) representing the galvanometer deflections produced when the current has been raised to a high value and has been subsequently reduced to a value indicated by the abscissæ. This curve may be properly called a descending curve. In the case of ordinary bodies this curve is a straight line coincident with the straight line of the ascending curve, but for iron is a curve such as is represented in the drawing. You observe that this curve descends to nothing like zero when the current is reduced to zero; and that when the current is not only diminished to zero, but is reversed, the galvanometer deflection only becomes zero when the reserved current has a substantial value. This property possessed by magnetic bodies of retaining that which is impressed upon them by the primary current has been called by Prof. Ewing "hysteresis," or, as similar properties have been observed in quite other connections, "magnetic hysteresis." The name is a good one, and has been adopted. Broadly speaking, the

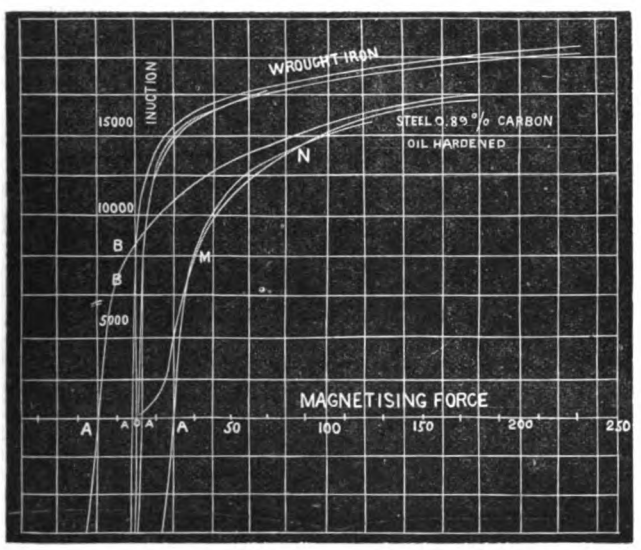


Fig. 3.

induction as measured by the galvanometer deflection is independent of the time during which the successive currents have acted, and depends only upon their magnitude and order of succession. Some recent experiments of Prof. Ewing, however, seem to show a well-marked time effect. There are curious features in these experiments which require more elucidation.

It has been pointed out by Warburg, and subsequently by Ewing, that the area of curve 2 is a measure of the quantity of energy expended in changing the magnetism of the mass of iron from that produced by the current in one direction to that produced by the current in the opposite direction and back again. The energy expended with varying amplitude of magnetising forces has been determined for iron, and also for large magnetising forces for a considerable variety of samples of steel. Different sorts of iron and steel differ from each other very greatly in this respect. For example, the energy lost in a complete cycle of reversals in a sample of Whitworth's mild steel was about 10,000 ergs per cubic centimetre; in oil-hardened hard steel it was near 100,000; and in tungsten steel it was near 200,000—a range of variation of 20 to 1. It is, of course, of the greatest possible importance to keep this quantity low in the case of armatures of dynamos, and in that of the cores of transformers. If the armature of a dynamo machine be made of good iron, the loss from hysteresis may easily be less than 1 per cent.; if, however, to take an extreme case, it were made of tungsten steel, it would readily amount to 20 per cent. In the case of transformers and alternate-current dynamo machines, where the number of reversals per second is great, the loss of power by hysteresis of the iron, and the consequent heating, become very important. The loss of power by hysteresis increases more rapidly than does the induction. Hence it is not well in such machines to work the iron to anything like the same intensity of induction as is desirable in ordinary continuous-current machines. The quantity O A when measured in proper units, as already explained—that is to say, the reversed magnetic force, which just suffices to reduce the induction as measured by the kick on the galvanometer to nothing after the material has been submitted to a very great magnetising force—is called the "coercive force," giving a definite meaning to a term which has long been used in a somewhat indefinite sense. The quantity is really the important one in judging the magnetism of short permanent magnets. The residual magnetism, O B, is then practically of no interest at all; the magnetic moment depends almost entirely upon the coercive force. The range of magnitude is somewhat greater than in the case of the energy dissipated in a complete reversal. For very soft iron the coercive force is 1·6 C.-G.-S. units; for tungsten steel, the most suitable material for magnets, it is 51 in the same units. A very good guess may be made of the amount of coercive force in a sample of iron or steel by the form of the ascending curve, determined as I described at first. This is readily seen by inspection of Fig. 3, which shows the curves in the cases of wrought iron, and steel containing 0·9 per cent. of carbon. With the wrought iron a rapid ascent of the ascending curve is made, when the magnetising force is small and the coercive force is small; in the case of the hard steel the ascent of the curve is made with a larger magnetising current, and the coercive force is large. There is one curious feature shown in the curve for hard steel which may, so far as I know, be observed in all magnetisable substances: the ascending curve twice cuts the descending curve, as at M and N. This peculiarity was, so far as I know, first observed by Prof. G. Wiedemann.

(To be continued.)

TEST OF THE NEW SPRAGUE STREET RAILWAY MOTOR.*

BY DR. LOUIS BELL.

A few weeks ago I had the opportunity to make a careful test of the new type of the Sprague motor, and the results, I think, are of sufficient interest to publish and discuss.

Most of the prominent American motors for street railway service seem to have settled down into a common and not altogether advantageous form; that is, a single magnetic circuit supported on the car axle at the yoke and furnished with a Siemens armature acting on the wheels through an intermediate gear. This form of magnet, although possessed of many advantages, makes a motor rather heavy in proportion to the power developed. A light weight motor constructed on this plan and having a relatively powerful armature is likely to have its field seriously distorted. The added weight necessary with this type is certainly a disadvantage for most purposes. American practice in this respect seems to be quite different from English practice, where a double magnetic circuit with consequent poles and an armature relatively quite powerful seems to be the rule, and this form of motor, such as is used by Reckenzaun and Immisch, weighs, for equal power, only about half as much as the American form of motor, while its electrical efficiency is quite as great. There may be mechanical reasons for the American practice, but the increased weight so decreases the economic ratio of the system, as explained in a recent Paper of mine, that efforts certainly should be made to build a lighter form of motor.

To illustrate this point, start to compute the economic ratio for a motor like the one under discussion, and then for a motor of the light-weight class. In the first case we may have a 16ft. car, weighing perhaps 3,000lb., carrying a full load of perhaps 4,000lb. of passengers, and motors weighing, as in the present case, 4,400lb. The ratio, then, between useful load and total weight is ·61. Com-

* From the *Electrical World* of New York.

Digitized by Google

pute now the same ratio for the same car and load of passengers, having, however, motors weighing but 2,500lb., a weight quite within the range of possibility. The ratio in this case will be ·77. It is therefore clear that even if the light-weight motor should have 10 per cent. less electrical efficiency it still would be the more economical. It ought to be quite possible to design a motor which should not weigh more than 80lb. per horse-power of normal output, and still retain a good electrical efficiency and reasonable freedom from heating. Such a motor would probably be somewhat greater in first cost, but its life should be very nearly as great as at present, and it certainly would be distinctly more economical in power than the present motors. Some of the Immisch motors for stationary service weigh less than 70lb. per horse-power output, and still have an electrical efficiency of 90 per cent. It should be remembered, however, that there is one case where the heavier motors are of service—when trailers are to be used extensively. In such case the increased tractional power gained by the added weight may well offset the disadvantages. Still a lighter form of motor is none the less necessary for those numerous cases where motor cars are alone employed or occasional trailers are used on light grades.

The new Sprague 15 horse-power motor has a single magnetic circuit, and the armature, instead of having a commutator at each end, has a single massive commutator containing 76 segments, with very narrow insulation between them. This change in the form of a commutator is a very decided improvement, both mechanically and electrically. The most marked difference between this new form of motor and the old one is, as is well known, in the winding both of armature and field, the resistance of the new motor being very much less. The connections with the switch-box are the same in each, and the resistances of the coupled motors, measured cold (about 65 Fahrenheit), are as follows :—

Step.	Old motors.	New motors.	Step.	Old motors.	New motors.
1	10·76	4·30	5	2·83	1·10
2	6·98	2·95	6	2·83	1·10
3	6·98	2·95	7	2·17	0·82
4	5·44	2·10			

The armature resistance of the old motor was about 1·2 ohms ; that of the new motor is less than one-tenth of an ohm. As a result of this difference the new armature is less likely to burn out than the old one. The gearing of the two motors, although different in detail, is about the same in effect ; in the old motor the armature makes 11·9 turns to one turn of the wheels, in the new motor 11¾ turns to one turn of the wheels. The new motor weighs 2,200lb., almost exactly twice the weight of the old.

The new motor was tested by running over a measured tenth of a mile on grade, noting the speed and measuring the electrical energy on the car by means of Ayrton and Perry ammeters and voltmeters. The grade was 6·58 per cent. on the same spot at which I had previously tested the old motor some months since ; the instruments used were the same in both cases, and the track, as nearly as I could judge, was in the same condition. The car, however, was but lightly loaded, and weighed about 7,800lb. complete. Runs were made up the hill on each step of the switch box, taking in each case a flying start, and the results were as follows : —

Step.	Rate.	Arm. Speed.	Watts.	E.H.P.
1	6·00	790	11,954	16·02
2	6·00	790	12,326	16·52
4	6·30	832	12,169	16·31
5	8·00	1,053	13,124	17·59
7	7·83	1,030	12,760	17·10

Some apparent discrepancies will be noticed in the above table. These are mainly due, I think, as they were in the previous test, to variations in voltage at the station. Computing now from these data the efficiencies of the motors we obtain far better results than with the old motor, as is shown in the following table :—

Step.	Motor E.H.P.	Motor E.M.F.	Electrical Efficiences.	
			New Motor.	Old Motor.
1	10·89	292	67·9	...
2	12·92	335	78·2	39·9
4	13·83	364	84·8	59·3
5	16·03	384	91·1	76·1
7	15·92	388	93·1	78·9

In the last column is given the efficiency of the old motor for comparison. It will be seen that electrical efficiency of the new motor is very high, and that consequently the heating is much less, especially in the armature, and the life of the coil must be correspondingly greater than in the old motor. In computing the above table 10 per cent. resistance was allowed for heating on steps two, four, and five, and 15 per cent. on steps one and seven, as these were taken last, and the heating, especially on step one, was severe compared with the heating on the other steps. At the completion of the test, which occupied about three-quarters of an hour, at the end of a full day's run up and down the same grade, the resistance of the coupled motors was again measured at the switch-box. The increased resistance gave approximately the amount of heating. The increase in resistance was nearly 16 per cent., which corresponds to a mean rise in temperature of about 72°F.

As to the commercial efficiency of the motors I can give no exact figures. The gearing being nearly the same as in the old motors, and the hysteresis being probably nearly the same—perhaps 500 watts—it is probably safe to allow nearly the same loss from these causes as in the old motor. I think one can safely say that the average commercial efficiency is somewhere about 75 per cent., possibly as high as 80. This is a distinct gain over the efficiency of the old motors.

It would seem that it should be possible to design a motor which should give satisfactory efficiency and yet need to be geared down but once. The intermediate gear is a constant source of noise and friction, which should be avoided if possible. With respect to efficiency, this new Sprague motor leaves little to be desired, but it is much to be wished that the skill of its designer could be further exercised to make a motor about two-thirds as heavy as the present one, and which would give at least as high a commercial efficiency as the old motor with an armature speed of 500 to 600 revolutions per minute. The task is not an easy one, but I do not think it at all impossible. Light weight and little gearing are two points which should in future be aimed at. It might be desirable even to have the armature act directly on the car axle without the intervention of gearing, but whether this advantage could be secured without too great a loss of efficiency and a too great increase of bulk and weight seems at present rather doubtful.

REPORT TO THE ST. PANCRAS VESTRY ON ELECTRIC LIGHTING.

BY PROF. H. ROBINSON, M.I.C.E.

The following is the report upon which the Vestry of St. Pancras recently resolved to ask for electric lighting tenders. The figures relating to scheme No. 2 have been omitted since the Vestry have decided to embark on the largest scheme :—

Gentlemen : Mr. Thos. Eccleston Gibb has thought that your convenience would be best met by my submitting to you in detail the cost of the two alternative installations of 10,000 and 5,000 lights which were suggested in my report of March last. The installation of 10,000 lights I will call scheme No. 1, the central station being in King's-road ; and the installation of 5,000 lights, with the central station in Edward-street, I will call scheme No. 2. At your meeting on the 14th October, the desirability of sub-dividing the contracts under several heads was referred to, and I stated that this would effect economy in carrying out the works. As I understood that you wished my estimates to be confirmed by tenders, I have gone very fully into the arrangement of the engines, boilers, dynamos, batteries, transformers, mains, &c., and have obtained provisional tenders from various leading manufacturers on which the figures hereinafter given are based.

The following is a description of the general arrangement of the works and of the system of producing and distributing the electric current. I propose to supply the consumers with a continuous current at a tension of 110 volts. The immediate neighbourhood of the central station will be supplied by a low tension (110-volt) dynamo feeding direct into the distributing mains, and the distant portions of the district will be supplied from sub-stations placed to suit the demand. The power will be transmitted from the central station, where it is generated, to the sub-stations by a constant continuous current, at a tension varying according to the demand, from about 500 volts to a maximum of 3,000 volts. This high-tension primary current will drive continuous current transformers at the sub-stations, and will produce secondary low-tension currents, which will be fed into the distributing mains. There will be a reserve of storage batteries, always charged, at each sub-station, which can be available as a stand-by in case of any sudden demand. The total amount stored will be about 800 units in No. 1 scheme (for 10,000 lights), and about 460 units in No. 2 scheme (for 5,000 lights).

The cost of producing a unit of electricity depends upon the size of the installation and upon the number of hours the lamps are used per annum, and I have prepared a table to show this in order that you may see clearly the advantage of commencing with an installation of 10,000 lights instead of with one of 5,000 lights. I have based my calculations upon the very liberal assumption that every additional 5,000 lights (beyond 10,000) will cost the same as the second 5,000 lights. The first column gives the number of 16 candle-power incandescent lamps which the plant is capable of

Digitized by Google

serving simultaneously. The number of lamps which may be safely installed will be considerably more than these, as it has been found in practice that the maximum number in use at one time lies somewhere between two-thirds and three-fourths of the number of lamps installed. The number of units sold per annum is taken at 80 times the number of lamps given in the first column for the first two cases, and then in diminishing proportion down to 70 times in the last case.

Number of lamps of 16 candle-power.	Cost of producing one unit (excluding sinking fund).
5,000	3·27 pence.
10,000	2·80 „
15,000	2·70 „
20,000	2·70 „
30,000	2·70 „

In calculating the above table I have taken non-condensing engines as being employed at the central station, which are less economical than condensing engines. The latter use about 25 per cent. less steam, saving therefore that percentage of coal and stoking, and this, with the reduction in depreciation of boilers, &c., represents about one farthing per unit. If condensing engines are employed, the above figures, therefore, would be reduced by about ·25 of a penny. No. 1 scheme is arranged for condensing engines, as the site admits of cooling the condenser water, but in No. 2 scheme I have provided for non-condensing engines, as the cooling of the condenser water at this site is likely to be affected by the surrounding buildings in Edward-street. The additional cost per unit to provide for the sinking fund may be safely taken at ¾d. in all cases, so that, after making due allowance for the sinking fund, the cost per unit will never exceed 4·02d. with non-condensing engines, or 3·77d. with condensing engines. These figures are arrived at after the details have been gone into, and may be accepted in place of the 4½d. per unit which I gave in my report of March. In my report of May I gave the price of an incandescent lamp up to 16 candle-power as 5s. I find that the present of these lamps is 3s. 9d., and this reduction in the cost of the lamp reduces also the cost of the renewals by a similar 25 per cent.

Scheme No. 1.

For 10,000 incandescent lights of 16 candle-power and 40 arc lights of 500 watts. The machinery at the central station (King's-road) is arranged for a maximum rate of output of 600,000 watts, delivered through five sub-stations, and 50,000 watts delivered direct to the mains, or a total output of 650,000 watts, which is equivalent to about 550,000 watts delivered to the lamps. The 10,000 incandescent lights will absorb 530,000 watts, leaving 20,000 watts to serve 40 arc lamps in the streets. There will be five sub-stations, arranged to supply as follows:—No 1, near the top of High-street, Camden Town; No. 2, near the middle of Albany-street; No. 3, near the south end of Hampstead-road; No. 4, near Goodge-street; No. 5, in or near Gordon-street.

Cost of Scheme No. 1.

Central Station, King's Road.

Buildings—Engine and boiler houses, foundation for engines, boilers, and dynamos, chimney and flues, offices, walls, gates, roads		£3,250
Tank for condenser water		540
Machinery—		
Five sets of Willans' II engines, combined with Siemens 120 unit dynamos	£7,750	
One set of Willans' GG engines, combined with Siemens 50-unit dynamo	800	
One 60-unit transformer	500	
Three boilers	2,250	
Surface condenser apparatus	1,000	
Feed pumps, steam mains, circulating pump, cooling apparatus, and travelling crane	1,050	
Regulating gear, electrical connections, instruments, tools, &c.	1,000	
		14,350
Total cost of central station		£18,140

Sub-Stations.

No. 1.—One 60-unit and two 30-unit tranformers	£1,100	
Batteries for 160 units	800	
Fittings and foundations	100	
		£2,000
No. 2.—Two 30-unit transformers	600	
Batteries for 160 units	800	
Fittings and foundations	80	
		£1,480
No. 3.—Four 60-unit and one 30-unit transformers	2,300	
Batteries for 160 units	800	
Fittings and foundations	300	
		£3,400
No. 4.—Same as No. 1		2,000
No. 5.— „ No. 2		1,480
Total cost of sub-stations		£10,360

Mains.

(These mains will serve fully 25,000 lights without additional feeders.)

½ mile with 2 sq. inches in each conducter	£1,725
½ „ 1½ „ „	1,425
1 „ 1 „ „	2,250
1 „ ¾ „ „	1,950
1 „ ½ „ „	1,650
2 „ ¼ „ „	2,500
Extra for divided main (*i.e.*, separate feeders) in ½ mile of above @ 3s. per yard	130
Extra for house junction T pieces, 6 miles @ £66 per mile	400
265 surface boxes or manholes	800
High tension mains, 9,350 yards at 8s. 6d.	3,880
Total cost of mains	£16,710

Summary of Cost of Scheme No. 1.

Central station	£18,140
Five sub-stations	10,360
Six miles of Mains	16,710
	45,210
10 per cent. contingencies	4,521
Total	£49,731

It will be noticed that the length of distributing mains included in the above estimate is six miles (or 10,560 yards), and 9,350 yards of high tension main. This latter length includes the return wires, and therefore only equivalent to 4,675 yards of double main. Adding this to the 10,560 yards of distributing main gives a total length of 15,235 yards, against the 22,000 yards stated in the Report of May (p. 13). The reason for the difference is that the six miles of distributing mains in the present estimate are made large enough to convey electricity to serve 25,000 lights working simultaneously, which, in my opinion, will be found to be the demand upon them. If the mains are laid at the outset of a size only to serve 10,000 lights distributed over the greater length of 22,000 yards of mains, their capacity will very soon be overtaxed, and it will then be necessary to take them up and lay larger ones, or to put down long lengths of additional feeders, at a cost which can be avoided by laying the mains as suggested. Small branch mains to serve 50 to 150 lights up side streets, where the demand is not likely to increase rapidly, can be laid at a cost of about £900 per mile.

The cost of running the arc lights will be as follows:—

500 watts acting for 3,808 hours per annum = 1,904 B.T. units at 3½d.	£27	15	4
Carbons and lamp lighter	10	16	0
Total	£38	11	4

40 lamps at £38. 11s. 4d. = £1,542. 13s. 4d. per annum.

These lamps would replace about 200 ordinary gas lamps, which now cost £560 per annum, so that the increase in cost would be £982. 13s. 4d. per annum, but with an increase of 14 times the present light, as stated in my May report. The prime cost of the 40 arc lights, if erected in the cheapest possible manner, would be about £1,000, or with ornamental posts and shelters about £3,000.

Annual Cost of Scheme No. 1 (Including Production of 825,000 Units).

Rent: Central station (ground)	£105	
Five sub-stations (cellars)	300	
		say £400
Depreciation of plant, &c.		3,400
Salaries: Engineers, assistants, and clerks		1,100
Labour: Engine drivers, stokers, &c.		1,500
Coal: 2,830 tons at 17s. 6d.		say 2,500
Water, oil, waste, and petty stores		500
Total annual cost		£9,400

to produce 825,000, or nearly 2¾d. per unit.

Annual Cost of Scheme No. 1 with Different Rates of Production.

The fixed expenses may be taken as follows:—

Rent	£400
Depreciation of plant	3,400
Salaries	1,100
Part of labour, coal, water, oil, stores, &c.	1,100
	£6,000

Annual cost when producing—

400,000	units = £7,666	or 4·60d.	per unit.
500,000	„ = 8,083	„ 3·88d.	„
600,000	„ = 8,500	„ 3·40d.	„
700,000	„ = 8,916	„ 3·06d.	„
800,000	„ = 9,333	„ 2·80d.	„
900,000	„ = 9,750	„ 2·60d.	„

If the current is used for motive power to any considerable extent, the plant will be able to meet a larger demand, as the motive power will be required at times when the machinery is not under full load for lighting purposes, and this will increase the revenue in a higher proportion than the working expenses, so much so that it might be well to encourage the demand for motive power by supplying the current at a lower price for that purpose.

Digitized by Google

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *December* 28, 1889.

The Overhead Wire Cutting in New York.—You will readily infer that the wire-cutter has been busy in this city when I inform you that since the work begun recently, after the Court had removed the injunction protecting the overhead circuits of the various companies, 154 miles of wire and 535 poles have been cut down. The work would probably have been done more rapidly, but for the fact that the Commissioner of Public Works experienced the greatest difficulty in securing good linemen. It was hardly to be supposed that the linemen in this city, or from any other, would be very enthusiastic in coming forward to remove the poles and wires that have afforded them a means of livelihood. In fact, it is supposed to be against the rules of the linemen's union to take any part in such work. Hence the destruction has been hampered by being committed to men unfamiliar with the handling of wires, and to others whose method of handling the axe would indicate that they do not hail from the backwoods. As might be expected, the work was attended by more than one accident, and even now it can hardly be looked upon as complete, for much remains to be done. The wires and poles, however, are no sooner down than there is a change of front and a change of tone on the part of the newspapers. The New York *Times* has called for a resumption of the arc light service as rapidly as possible wherever it has been interrupted. The *Evening Post*, a prominent evening paper, has remarked that no city which has known and enjoyed the blessings of electricity will ever go back to gas. The New York *Sun* says there is no doubt that the electric light can be made safe, so far, at least, as ordinary contingencies go, and that its vast superiority to every other for public and very many private uses justifies any cost which such safety will render necessary. It adds: "The period of deprivation, therefore, will be short, and when the light is again made available for safe use in all parts of the town, the demand will be greater than before, and the cost of the improvement will be recompensed. The companies can afford to incur the additional expense now that it has been practically demonstrated that they provide the community with what is indispensable to modern life." With regard to what is immediately before us, it may be taken for granted that the companies will have a good suit against the city for the destruction of many of their circuits, which consisted of the best insulated wires known to-day for the purpose, and which were, undoubtedly, thoroughly adequate to all reasonable requirements of public safety. It mattered little to the wirecutters whether the circuits were good or bad. A wire was a wire, and away it went, whether its insulation was frayed and ragged underwriters', or whether it was the best that money and science could provide. The sudden change in affairs, too, has naturally stimulated the demand for underground wires and cables; but it will, no doubt, be several weeks before these can be got ready, since they not only have to be made, but the delicate work of splicing has to go on under the unfavourable conditions of winter. It is said that the cables in the subways are now giving better results than were expected. This is probably true, although it is not less a fact that a great deal of cable work put in as recently as twelve to eighteen months ago, has already succumbed, and has had to be taken out. And then, moreover, there is the question whether the new subways, which have been rushed at such a great rate, will not develop serious defects when they come to be used. It is possible, moreover, that we may continue to have subway explosions. One occurred only last week, and was so complete a performance in its way that one wonders how on earth the passers-by escaped.

The Government v. the Bell Telephone Company.—It is worth while to note in passing that the Government is continuing its work with regard to the prosecution of the suit of the United States against the Bell Telephone Company. This suit, as I may remind you, was brought mainly on two grounds—first, that the Bell patent was obtained by fraud, and, next, that Daniel Drawbaugh was a prior inventor. The other prior inventors of whom we have heard so much seem to have been relegated to the background, but if one may judge from what the Pennsylvania papers say, a good deal of importance is attached by the Government lawyers to the work of the old blacksmith of Eberly Mills. An examiner is now taking testimony at Harrisburg, and, of course, we have the re-appearance of the country fakirs, who say that they used the telephone in Drawbaugh's workshop away back in 1873 and 1874. The supporters of Drawbaugh claim that they have important new evidence to bring forward, but it is hard to believe that at this late date, after the case has been so thoroughly thrashed out, there is anything to be developed to which the word "important" can properly be applied.

A Challenge to the Edison System.—The United Electric Light and Power Company and the United States Illuminating Company, of this city, have issued an open challenge to the local Edison Electric Illuminating Company for an expert investigation of their respective systems of electric lighting. The challengers complain that the challengee has been spreading incorrect and misleading statements about the converter system of incandescent lighting, and has tried to influence the Board of Health against it.

The Progress of the Alternating System.—It is interesting, in this connection, to call attention to the fact that the alternating system is still having rapid development in this country, and that there is no slackening in the demand. According to figures published by the Westinghouse Electric Company, their shipments of alternating current apparatus for eleven months of the year 1889, ended November 30th, amounted to a capacity of 223,600 16 candle-power incandescent lamps. During the entire year 1888 the total amount of business represented a capacity of 106,200 16 candle-power lamps, and during 1887 119,950 16 candle-power lamps, making for those two years a total capacity of 226,150 16 candle-power lamps. From these figures it is not difficult to gather the fact that the total amount of business done by the Westinghouse Electric Company during the year 1889 will more than double the amount of last year's business, and it will even exceed the combined amount of the business accomplished during 1887 and 1888. It is to be borne in mind that this is not the whole of the alternating-current business, since the Thomson-Houston Company, the Brush Company, the Fort Wayne Company, and one or two others are also supplying the field, and are nearly all of them doing a large business.

The "Double-Carbon" Lamp Patent.—Many of your readers will, doubtless, be interested to learn that at Indianapolis, Ind., on December 24th, in the United States Circuit Court, Judge Gresham decided a suit brought by the Brush Electric Company, of Cleveland, against the Fort Wayne Electric Light Company for infringing the Brush patent upon the so-called "double-carbon" lamp. The case has been vigorously prosecuted and defended, and has been pending about three years. All of the claims of the Brush patents are sustained, six in all, and declared to be infringed. These claims cover the all-night electric lamps used for street lighting, where two or more pairs of carbons are employed, one pair being first burned and then another automatically consumed. The patent was attacked by the defence mainly upon the grounds that its claims were too broad and sweeping, but this defence did not avail. It is worthy of note that both the litigants are now controlled by or in alliance with the Thomson-Houston Company.

SCANDINAVIAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

COPENHAGEN, *December* 31, 1889.

The telephone does not seem able to extend fast enough in Sweden, where both State and private enterprise are working with a will for the advancement of telephony. As I have already mentioned the Swedish Government has granted 750,000kr. (£40,000) for State telephones, to be expended at the rate of 150,000kr. (£8,000) per annum. The line taken in hand for the year 1890 is that between Stockholm and Malmö. For the following year the State Telegraph officials contemplate erecting a line between Stockholm and Hernösand, with a branch to Sollefiia. One use of the telephone which has been adopted in Sweden, has proved very serviceable in

Digitized by Google

a great many instances: Steamers, while in port, are joined to the telephonic system. Of course the steamers must have the necessary appliances on board, but it is evident that this arrangement is a very practical and time-saving one, which would assuredly prove most desirable in a number of English ports.

The reduction which took place in the charge for inland telegrams in Sweden at the beginning of the present year has brought about a very material increase in the number of telegraphic messages despatched. During the first nine months the number of inland telegrams exceeded the number for the corresponding period of 1888 by 243,797 telegrams, or about 54 per cent., while the receipts were almost identical with the figures for the previous year. During the same period the number of foreign telegrams had risen 2 per cent., and the receipts 4 per cent.

The town of Bergen, in Norway, is contemplating the erection of a central station. A representative of the Thomson-Houston International Electric Company is on the spot explaining the merits of that Company's system. The Corporation is willing to grant a concession, but not a monopoly. The capital required is about £20,000.

A large telephone company for Western Norway is about to be formed, and application has been made to the Government for a concession. A considerable portion of the necessary money has already been subscribed.

The immense distances at which a powerful electric light can be seen has just been forcibly illustrated by the new electric light-house at Houstholm, the light of which has been sighted from outside Mandal, Norway, a distance of about 70 miles; also from Fläkkerö, at Christiansand, Norway. The flashes from Houstholm have been seen high up in the air as narrow rays.

The Östermalur church at Stockholm has just had electric light installed, and is the first church in Sweden which has been lighted in this manner. The installation was carried out by the firms of Luth and Rosen and the Elektriska Bolaget, Stockholm. The cold weather recently experienced at Stockholm has caused a lot of breakages on the telephone wires. Both the telephone companies have had many broken wires, resulting in a large number of interruptions.

The electrical engineers in Sweden and Norway, more so than in Denmark perhaps, are busy, and not only do the various installations materially increase, but the manufacture of various electric appliances is also extending. The Great Northern Telegraph Company at Copenhagen is going to build a very handsome block of houses for offices, &c. The building is in the principal square of the city.

CORRESPONDENCE.

THE HOUSE-TO-HOUSE STATION AT WEST BROMPTON.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I notice that in *The Electrician* of January 3rd, under the heading "Central Lighting Stations of the United Kingdom, London," the West Brompton Station of the House-to-House Electric Light Supply Company (Limited), is described as using "the alternating current (Parker Alternators and Transformers)," which is incorrect, the system in use being the same as adopted at Eastbourne and Brighton, viz.: The Lowrie-Hall System of Alternating Current Transformers. I should feel obliged if you will kindly insert this letter in the next issue of your valuable paper. Thanking you in anticipation,—Yours, &c., CHARLES J. HALL, Manager.

Kensington Central Electric Lighting Station,
January 6, 1889.

LEGAL INTELLIGENCE.

Inland Revenue Department v. the Mines and General Telpher Company.

Before Messrs. J. McCall and S. L. Stacey and Major Taylor, the divisional justices sitting at the Edmonton Petty Sessions on Saturday last, the Mines and General Telpher Company (Limited), of 12, Great George-street, London, appeared to answer a summons, issued at the instance of William Leghorn, officer of Inland Revenue, for having, on August 17th, at the parish of Wood-green, kept five carriages, for the keeping of each of which a licence was required by the statute, without having proper licences.

Mr. ROBINSON, who conducted the prosecution, said the case was an important one from the point of view of the Inland Revenue authorities, because it was the first case of the kind which had been brought forward in the neighbourhood of London, if not over the whole of the United Kingdom. The offence with which the company was charged was that of having an electric tramway, and running thereon five carriages carrying passengers from the entrance to the Alexandra Park to the doors of the Alexandra Palace, the carriages being unlicensed.

Mr. CHRISTIE, who appeared for the defence, said his clients considered that their line was a railway, and they did not wish to avoid the payment of any duty for which they might be held liable by the Bench. This was a new invention, and they wanted to find out what they were really liable for. He contended that his client's cars did not come under the definition of a carriage, because they did not ply for hire, and could not be stopped like a tram car between the fixed stations.

The CHAIRMAN of the BENCH, after a consultation, said they were disposed to find that the carriages referred to in the summons did not come within the definition of a carriage subject to taxation. The Bench thought it was a sufficient reason of exemption that they ran on rails, though it was not a statutory railway.

Mr. ROBINSON intimated that the decision would be appealed against.

The South of England Telephone Company.

The Recorder of Brighton (Mr. P. C. Gates, Q.C.) had before him on Monday and Tuesday an appeal by the South of England Telephone Company against the poor rate. The overseers had assessed the property of the Company in the parish at £650 and £500 rateable value. The appellants, while admitting that the wires connecting the telephone were rateable, contended that the telephones themselves, and the apparatus connected with them, were chattels, and, therefore, not rateable, and as to the rateable value of their property, showed that it was a minus quantity of £985. Mr. Poland, Q.C., and Mr. Besley represented the appellants, and Mr. Castle, Q.C., and Mr. Gore the respondents. The witnesses for the appellants were Mr. Ponsford, solicitor to the Company; Mr. Francis Cowley, district superintendent; and Mr. Charles Barker, engineer and surveyor, of London. For the respondents Mr. W. Castle, F.S.I., and Mr. W. H. Ellwell, surveyor-in-chief to the Great Northern Railway Company, were called. The Learned Recorder reserved judgment until next Quarter Sessions.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning.*]

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1890.—We call the attention of the electrical public to the fact that entries for insertion in the Alphabetical and Classified Trades Sections of the forthcoming edition cannot be inserted in their proper places unless received immediately.

TENDERS WANTED.—Our advertising columns contain a notification that the Guardians of the Poor of the Sheffield Union are desirous of obtaining tenders for connecting the various parts of their workhouse buildings to the fire station by electric bells.

TELEPHONE PATENTS FOR SALE.—Particulars will be found in our advertising columns of several telephone patents which are for sale.

ELECTRIC LIGHTING IN SOUTH WALES.—To demonstrate the great strides which electric lighting is making in popular favour, we may mention that Mr. J. C. Howell, of Llanelly, has, within the year 1889, installed 65 arc lamps, and over 3,500 incandescent lamps in South Wales, besides other electrical work, such as electrical transmission of power for pumping plants in the Rhondda collieries, &c.

THE ENDOLITHIC IVORY COMPANY (LIMITED).—We are requested to notify that this company are now connected by telephone, No. 21.

STANHOPE PATENT TELEPHONES.—The latest list of the Stanhope Company gives illustrative particulars of the Stanhope patent electro-magnetic telephones, which are sold outright without royalty, and which are guaranteed not to infringe the National Company's patents. Accompanying the sheet of prices, &c., is a list of many large establishments where the Stanhope telephones are in use.

BELL'S ASBESTOS COMPANY (LIMITED).—We have received from this firm a very useful, well-printed Calendar for 1890, and a revised list of the new-pattern cocks and water-gauges made by the firm. These are neatly illustrated in section. These cocks and gauges are made to any design or measurement, although the price list under notice gives examples of only a few of the regular sizes.

FITCH BATTERY AND ELECTRIC COMPANY, NEW YORK.—The catalogue and trade list of this Company contains illustrated particulars of the "Chlorine" battery, for telephone, telegraph, electric bell, and other open service work. From the testimonials accompanying the list, the battery is in good repute in the States.

Digitized by Google

PATENT RECORD.

APPLICATIONS FOR PATENTS.

19,861A. C. H. Logan. London. Improvements in plates for secondary voltaic batteries.
[This application having been originally included in No. 19,681, dated December 10, 1889, takes, under Patents Rule 23, that date.]

December 21, 1889.

20,565. C. H. Bell. London. An arrangement of electric light for steamers' chart table, or for a reading desk.
20,582. J. Einstein and S. Kornprobst. London. Improvements in electric meters and indicators.

December 23, 1889.

20,627. W. M. Mordey. London. Improvements in electric distribution.
20,645. J. A. L. Dearlove. London. New or improved means for protecting the metallic coating of telegraph cables from corrosion.
20,646. G. A. Cassagnes. London. A new or improved printing telegraph apparatus.
20,652. J. W. Edmundson and W. Clarke. London. Improvements in incandescence electric lamps.
20,653. W. Foster and C. Griffiths. London. Improvements in covers or protectors for telegraphic insulators.
20,660. J. O. Winckler. London. An improved electric signalling apparatus.

December 24, 1889.

20,717. H. S. Prentiss. London. Improvements in electric cams.
20,734. R. Huddan. London. Improvements in magneto-electric machines (C. F. Gillette, United States).
20,751. F. Marx. London. Improvements in electrical accumulators.
20,752. F. Marx. London. Improvements in the manufacture of electrodes for electric batteries.
20,764. W. P. Thompson. Liverpool. Improvements in or relating to armatures for electric machines (Westinghouse Electric Company, United States).

SPECIFICATIONS PUBLISHED.

1888.

14,161. Bollmann. Producing electro-magnetic inductions. (Price 1s. 3d.)
18,331. Holt. Electro-dynamic engines. (Price 8d.)
18,450. Johnson (Bradley). Dynamo-electric machines. (Price 11d.)

1889.

915. De Ferranti. Electric switches. (Price 8d.)
1,057. Adams-Randall. Electric date, &c., stamps. (Price 11d.)
1,823. Coleman and Jackson. Telephonic apparatus. (Price 8d.)
2,137. Gwosdeff. Magnetic telephony. (Price 8d.)
2,252. King. Measuring electric currents. (Price 6d.)
2,299. Desruelles and Chauvin. Measuring electric currents. (Price 6d.)
2,413. Wright and Moore. Printing telegraphs. (Price 6d.)
3,130. Fraser. Telephonic instruments. (Price 6d.)
6,628. Scott and others. Electrical underground mains. (Price 8d.)
11,018. Weems. Electric railways. (Price 1s. 1d.)
11,300. Lake (Van Choate). Electric lamps. (Price 6d.)
11,615. Reed and McKibbin. Electrical railway conduits. (Price 8d.)

COMPANIES' MEETINGS.

United River Plate Telephone Company (Limited).

An extraordinary general meeting of this Company was held at Winchester House, Old Broad-street, on Thursday, under the presidency of the Right Hon. Lord Thurlow.

The notice convening the meeting having been read by the Secretary (Mr. J. Owen Unwin),

The CHAIRMAN said that the object of the meeting was to authorise a financial operation of two-fold significance. In the first place they desired to increase the working capital by the sum that was now required for their extended operations, and which, as he would proceed to point out presently, was perfectly justified by the extensions they were making in several directions; and in the second place they wished to take that opportunity of reducing the rate of interest that they paid for their debenture debt. He thought they would agree with him that the position which the Company now occupied was not one which justified their continuing to pay 7 per cent. annually for their Debentures, and the best proof of that was that the Board found that there was no difficulty in converting them into a 5 per cent. charge. The net result of the operation when it was fully carried out—at least when it was carried out to the extent proposed at the present time—would be to give the Company an issue of £150,000 for only £500 a year more than they now paid for the use of £100,000—that was to say, that they would have to pay £500 a year, or 1 per cent., for the use of an additional £50,000. He thought that would be regarded as a very favourable financial operation. He would like now to give a few figures indicative of the progress the Company had made. When they commenced business, as nearly as possible three years ago, the number of subscribers was about 3,200. The capital at the commencement of the Company, as would be remembered, was £250,000 in shares and £50,000 in debentures, making a total capital of £300,000. That represented a capital as nearly as possible of £94 per head per subscriber. The number of subscribers on October 31, 1889, at Buenos Ayres, La Plata, and Rosario, was about 5,300, and the present capital amounted to £290,000 in shares and £100,000 in debentures, making a total of £390,000; and if they calculated that out, adding about £8,000 since spent, it would be found to amount to as nearly as possible £74 per head per subscriber, instead of £94. That was to say, that they had over half as many additional subscribers, and the proportion to capital expenditure was reduced by 20 per cent. That was, he thought, a very favourable condition of things, showing—and he had no doubt of it whatever—that as time went on and if the number of subscribers increased at the rate at which it had hitherto done, the cost in proportion to capital would fall in about the same ratio. There were one or two other things that he would like to trouble the meeting with before they proceeded to the resolutions proposed to be submitted. He thought they might rely upon the position they occupied that day being certainly very much stronger and sounder than the one they occupied at the commencement of their business, and he felt sure if it had not been so it would not have been so easy for the Directors to come before them and suggest their taking such a course as that which was now under consideration; and he thought the best proof that he could adduce of the existing strength of their position and their prospects of success was the fact that they came now before the shareholders with their proposals at a time when the bank rate was 6 per cent., and when they could not borrow money in the streets of London much under 7 per cent., and when the price of gold at Buenos Ayres was 135 per cent. He thought these two circumstances were more eloquent than any words of his could possibly be, and could not fail to satisfy even the most critical of shareholders of the wisdom of their policy. He was bound to say that all the letters they had received—and they had received a great many from absentee shareholders who were unable to be present on that occasion—had expressed, with but two or three exceptions, complete satisfaction

PATENT
SILICIUM BRONZE AND SILICIUM COPPER WIRE.
The best for overhead Telephone and Telegraph Lines,
AND ALL ELECTRICAL PURPOSES.
Hard Drawn High Conductivity Copper Wire.
ROLLED AND DRAWN
PHOSPHOR BRONZE.
PHOSPHOR BRONZE
BEARINGS, BUSHES,
AND OTHER PARTS OF
ELECTRICAL MACHINERY.
SOLE PROPRIETORS of the British, Indian and Colonial Patents,
THE PHOSPHOR BRONZE COMPANY (Limited),
87, Sumner Street, Southwark, London, S.E.
WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

Digitized by Google

with what it was proposed to do. He was glad, however, that there were some shareholders present, because it was always satisfactory to hear by word of mouth any criticisms that could be made. But he felt sure that no criticism could be made as to the course they were adopting that day which could not be easily and satisfactorily answered. As regarded future expenditure, they had received inquiries as to what the estimated cost would be for the trunk line that they proposed to make between Buenos Ayres and Rosario, to connect their new exchange at Rosario with the old and large exchange at Buenos Ayres. The cost would depend on circumstances, and on how the business developed, as well as on the number of metallic circuits that would have to be laid down, but there was every prospect of that trunk line being made with the utmost possible economy. They would follow the line of the existing railway between Buenos Ayres and Rosario. The railway company had met them in the most friendly spirit, and had promised to afford them in the future the most ample facilities for carrying out the work, so that he could assure the shareholders that, whatever the cost might be, they might rest satisfied the trunk line would be constructed on the most economical principles consistent with efficiency. As regarded figures, he need not go into details. With respect to other expenditure, of course their system was growing, and they had to connect new streets, new houses, and new suburbs. All that took money, but there were certain opportunities afforded, as those extensions were rendered necessary, of affecting economies; and they would be blind to their own interest if they did not incur a little expense for the sake of perfecting their arrangements as they went along. He might mention that, for existing extensions which they were compelled to make, £8,000 as nearly as possible had already been spent. They did not propose at the present moment to go to the full extent of the issue for which they asked powers. They proposed to issue additional capital for expenditure just now to the amount of £29,000. There was only one other point to which he wished to draw attention, and it was a matter which had come only too prominently before them, and that was the extraordinarily high rate of gold at Buenos Ayres, which had curtailed their dividend by nearly one-half at the present time. That was a circumstance which they on this side had no control over. It was an unfortunate circumstance, but he thought it was on the whole satisfactory to know that the prosperity of the Company was such as enabled it to withstand so great a strain on its profits, and at the same time be able to offer what was no inconsiderable dividend to the shareholders. He believed the Company in the future would pay from, say, 5 to 7 per cent. dividend in bad years, and from, say, perhaps, 10 to 12 per cent. in good years. He did not like to prophesy, and anything he said must be subject to circumstances such as those he had alluded to, over which the Directors had no control; but, reasonably speaking, he did not see why the anticipations he had attempted to foreshadow as to their earnings in the future should not be fulfilled. He then moved:

"*That debentures or debenture stock of the Company providing for the payment of principal sums not exceeding in the aggregate £200 000, be created and issued at such times, in such manner and form, on such terms and conditions, bearing such rate of interest, with such stipulations as to redemption at a premium or otherwise, and secured in such manner as the Directors shall think expedient. Provided that so long as any of the existing debentures of the Company which fall due on January 1, 1907, shall be outstanding or uncancelled, the nominal amount of the new debentures or debenture stock from time to time issued under this resolution, together with the nominal amount of the existing debentures so outstanding or uncancelled, shall not exceed the sum of £200,000.*"

Mr. J. IRVING COURTENAY (Deputy-Chairman) seconded the resolution, which was unanimously adopted without discussion.

The CHAIRMAN then moved and Mr. COURTENAY seconded the next resolution as follows:—

"*That the Directors be and they are hereby authorised to redeem all or any of the existing debentures by exchanging them for any of the new debentures or debenture stock, or by payments in cash, or in such other manner and at such premium or rate of exchange as they shall think expedient, and that pending the issue of the new debentures or debenture stock, the Directors be and they are hereby authorised to borrow on such terms as they may think fit any moneys for the purpose of redeeming any of the existing debentures, or for any other purposes of the Company.*"

The resolution having been carried unanimously, a vote of thanks was passed to the Chairman, and the proceedings terminated.

NEW COMPANIES REGISTERED.

ELECTRICAL STANDARDISING, TESTING, AND TRAINING INSTITUTION.—This institution is formed to establish, maintain, and carry on in England or elsewhere any standardising, testing, or calibrating institution or institutions, where all or any electric measuring instruments can be tested, calibrated, or standardised, and for other like purposes. Capital £10,000, in £5 shares, of which the first 100 are founders' shares. Subscribers of one share each are: W. A. Pitman, 7, St. Helens-gardens; James Whitehead, electrical engineer, Crouch End; Thomas E. Towerson, F.C.S, analytical chemist, 1, Portland-road, Finsbury Park; H. Linklater, accountant, 117, Bishopsgate-street; R. Acock, secretary, same address; J. A. Roxburgh, clerk, same address; and Oscar W. Seligman, 3, Moreton-gardens, South Kensington.

SYNDICATE OF ELECTRICAL ENGINEERS.—The objects, capital, and signatories to the Memorandum of Association of this syndicate are the same as those of the Electrical Standardising, Testing, and Training Institution above.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended January 3rd amounted to £4,974.

CUBA SUBMARINE TELEGRAPH COMPANY.—The estimated traffic receipts of this Company for the month of December, 1889, were £3,000, as compared with £3,508 in the corresponding month of last year. The receipts for the month of September, estimated at £2,400, realised £2,372.

DIRECT SPANISH TELEGRAPH COMPANY.—The traffic receipts of this Company for the month of December were £2,137, against £1,908 in the corresponding period last year, an increase of £279.

DIRECT UNITED STATES CABLE COMPANY (LIMITED).—The Board of this Company have resolved upon the payment of an interim dividend of 3s. 6d. per share, free of income-tax, being at the rate of 3½ per cent. per annum for the quarter ending December 31, 1889, such dividend to be payable on and after the 24th instant.

EASTERN TELEGRAPH COMPANY.—This Company's traffic receipts for the month of December amounted to £56,862, as against £59,834 in the corresponding period of 1888, a decrease of £2,972.

EASTERN EXTENSION TELEGRAPH COMPANY.—The traffic receipts of this Company for the month of December were £40,362, as against £38,699 for the same period of 1888.

GLOBE TELEGRAPH AND TRUST COMPANY.—This Company have declared an interim dividend of 1s. 9d. per share, payable on the 18th inst.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic returns of this Company for the month of December amounted to £22,400. From January 1st to December 31st they were £274,800, against, in the corresponding months of 1888 and 1887, £272,200 and £264,480 respectively.

SCHANSCHIEFF ELECTRIC BATTERY SYNDICATE.—An extraordinary general meeting of the Schanschieff Electric Battery Syndicate (Limited) was held on Monday last at the offices, 44, Basinghall-street, E.C., for the purpose of considering a resolution for the voluntary winding up of the Company and the appointment of liquidators.

WEST COAST OF AMERICA TELEGRAPH COMPANY.—The traffic receipts of this Company for the month ended December 31st amounted to £6,375.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The receipts of this Company for the half-month ended December 31st amounted to £2,643, against £2,392 in the corresponding period last year, an increase of £251.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended January 3rd, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited) were £3,682.

PERSONAL.—Mr. Charles Burt has been appointed a director of the Anglo-American Telegraph Company, in place of the late Sir Daniel Gooch.

THE NON-CONDUCTOR OF ELECTRICITY.

VULCANISED FIBRE,

PATENTED.

This new material is supplied in two qualities, Flexible and Hard.

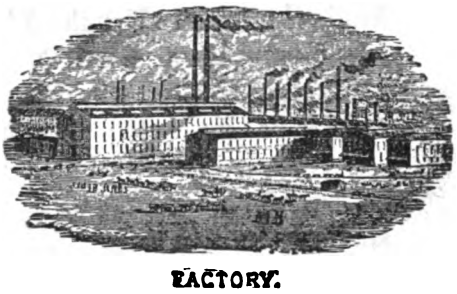
The FLEXIBLE is a substitute for Leather, Rubber, Gutta Percha, &c., and is extensively used by Brass Founders, Axle Makers, Hydraulic, Sanitary, and other Engineers, Pump Makers, Carriage Builders, &c.

It makes the best Hot and Cold Water Packings, and for Axle Washers of all kinds it is unequalled.

The HARD is a substitute for Metals, Hard Wood, Ivory, Vulcanite, Ebonite, &c., and is a good Insulator.

Sold in sheets, 5ft. 6in. by 3ft. 6in., varying in thickness from 1-50th. to 1in.

FLEXIBLE, 2/- per lb.; HARD, 2/3 per lb.



FACTORY.

MOSSES & MITCHELL, 70 Chiswell-st., London, E.C.

Digitized by Google

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Wednesday, Jan. 8, 1889.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending Jan. 8, 1889.	
			TELEGRAPHS.		£ s. d.		Highest.	Lowest.
£								
1,770,360	Stock	12/6	Anglo-American	52 53	5 3 9	Jan., Apr., July, Oct.	52⅝	52
2,614,820	Stock	25/0	Do. Preferred	87 88	6 5 0	,, ,,	88⅜	87½
2,614,820	Stock	...	Do. Deferred	16¾ 17¼	...	February	17 1/16	...
130,000	£10	3/0	Brazilian Submarine xd	12¼ 12⅜	5 17 8	Mar., June, Oct., Dec.	12⅜	12¼
112,900	£100	5%	Do. 5 per Cent. Bonds	101 103	4 17 1	January and July	102	...
75,000	£100	5%	Do. Do. (2nd Series, 1906) xd	104 107	4 13 6	June and December.	...	...
16,000	10	9/0	Cuba Submarine	14½ 15	6 0 0	February and August	...	...
6,000	10	10/0	Do. Preference 10%	19½ 20½	4 19 9	,, ,,	...	...
12,931	5	2/0	Direct Spanish (£4 paid)	4 4½	4 8 11	March & September	...	...
6,000	5	5/0	Do. Preference 10%	9 10	5 0 0	April and October	...	...
60,710	20	3/6	Direct United States	10 10½	6 13 4	Jan., Apr., July, Oct.	10 7/16	10⅛
380,000	10	2/6	Eastern	14 14½	4 11 3	,, ,,	14½	14
70,000	10	3/0	Do. 6 per Cent. Preference	15¼ 15⅞	3 16 2	,, ,,	15⅞	...
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock	104 106	3 15 6	May and November.	106½	105⅛
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	107 110	4 10 11	February & August	109¼	107⅜
250,000	10	2/6	Eastern Extension	13¾ 14	4 12 10	Jan., Apr., July, Oct.	14	13⅝
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	102 104	3 16 1	February & August	...	...
473,000	100	5%	Do. 5 per Ct. (Austrln. Gov. Sub.) Debs. 1900	102 105	4 15 3	January and July	103½	...
179,177	10	2/0	Globe Telegraph and Trust	8⅞ 9	5 13 7	Jan., Apr., July, Oct.	9	8⅞
178,992	10	3/0	Do. 6 per Cent. Preference	14½ 15	4 0 0	,, ,,	14 13/16	14½
150,000	10	5/0	Great Northern xd	15¾ 16¼	4 12 4	Jan., July, and April	16	15⅞
17,000	25	12/6	Indo-European	41 43	5 16 3	April and October	...	...
9,000	8	4/0	Reuter's	7 7½	5 6 5	April and October	...	...
15,609	10	3/6	West African Telegraph xd	9½ 10½	...	...	10 5/16	9⅛
300,000	100	5%	Do. 5 per Cent. Debentures	99 102	4 18 0	March & September	102	100
30,000	10	5/0	West Coast of America	11¼ 11⅜	4 5 1	January and July	11½	...
150,000	100	8%	Do. Debentures 8% xd	119 124	6 9 1	June and December	120¾	...
88,321	10	nil.	West India and Panama	2⅞ 3⅛	...	...	3	2⅞
34,563	10	12/0	Do. 1st Preference 6%	11½ 12	...	April and October	...	...
4,669	10	10/0	Do. 6 per Cent. 2nd Preference	14½ 15½	...	...	...	...
45,181	15	6/0	Western Brazilian	9½ 10	...	May & November	9⅞	9⅝
$1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	118 122	5 14 9	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	100 102	5 17 2	March & September	...	...
			TELEPHONES.					
224,850	14/0	5%	Consolidated Telephone and Maintenance	9/16 11/16	...	Yearly	...	...
220,000	£1	3%	Oriental (11s. paid)	7/16 7/16	3 15 11	...	...	...
*	*	6%	National	...	...	...	5 5/16	5⅛
55,000	5	3/0	United River Plate	4½ 5	...	January and July	...	...
			ELECTRIC LIGHT.					
23,692	5	...	Anglo-American (fully paid)	...	...	February & August	...	...
79,934	5	6%	Swan United (£3. 10s. paid)	4¾ 5¼	4 0 0	...	5⅛	5
500,000	10	...	Metropolitan Electric Supply (£3 paid)	4¾ 5¼	...	...	5¼	4⅞
			MISCELLANEOUS.					
37,350	12	12/0	Telegraph Construction and Maintenance	44 46	5 4 9	March and July	45½	45¼
41,600	10	10/0	India Rubber, Gutta Percha & Telegraph Works	18 19	5 5 3	February & August	...	...

JABLOCHKOFF'S
DISTRIBUTION PATENT

(Being a Patent for "Producing and Dividing Electric Light," No. 1996 of 1877.)

THE UNITED ELECTRICAL ENGINEERING COMPANY (LIMITED)

Are Proprietors of the above Patent, and Warn the Public against Infringement.

The following are Licensees:—

Anglo-American Brush Electric Light Corporation, Limited.
Crompton & Co., Limited.
S. Z. de Ferranti.—London Electric Supply Corporation, Limited.
W. T. Goolden & Co.
Hammond & Co.
Wilson Hartnell.
Johnson & Phillips.
Laurence, Paris & Scott, Limited.
Nalder Brothers & Co.
Paterson & Cooper.
Ernest Scott & Co.
Siemens Brothers & Co., Limited.
J. G. Statter & Co., Limited.

3, Prince's Mansions, Victoria Street, Westminster.

MANVILLE & MADGEN, *Managing Directors.*

Digitized by Google

THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 609.—Vol. XXIV. FRIDAY, JANUARY 17, 1890. Price Fourpence.

NOTES.

The terms in which the retiring President of the Institution of Electrical Engineers spoke last week of the achievements of submarine cable laying, and of the eminent men associated with it who had virtually founded the profession of electrical engineering, were at once appropriate and well-timed. No one is better qualified to offer an opinion on these points than Sir W. Thomson, and his public testimony, coupled with the election of Sir James Anderson, Sir Albert Cappel, and Sir Henry Mance to the Council of the Institution, will afford much satisfaction, we doubt not, to the members generally, but especially to that numerous and influential group of them who sympathised with the complaints which found expression recently in our correspondence columns.

Before quitting this subject, however, we have a less agreeable task to perform in connection with it. The Institution some time ago resolved to exclude reporters from its meetings; and although we questioned the policy of this decision, we have loyally abided by it. Last week's proceedings were of such importance, however, that we made inquiry as to whether any exception would be made on that occasion, and were answered in terms which practically precluded us from sending our reporter. It will now be seen that we print this week the remarks of Sir W. Thomson commented upon above, but that we are indebted to *The Times* for that privilege. Of course it is possible that *The Times'* reporter may have been present disguised as a Member of the Council; but the more probable theory appears to be that what is denied to the electrical press is conceded to the all-powerful thunderer.

We publish this week some important regulations relating to the supply of electricity which it is the intention of the Board of Trade to enforce in connection with all methods of electrical distribution. These regulations are at present only in draft form, and it may be anticipated that they will receive considerable modifications at the hands of the various authorities and bodies interested, to whom they have been submitted. This latest contribution of the Board of Trade to the already formidable array of electric lighting rules and regulations, although it bears the impress of having been drawn up to some degree under the influence of recent transatlantic events, does not, taken as a whole, lay down conditions impossible of attainment in ordinary everyday commercial distribution.

It will be observed that the Board of Trade have wisely abandoned their hard and fast current density rule for conductors, and have substituted for it a temperature limit. On the other hand, in Section 7, they lay down that the insulation resistance of any complete circuit used for a high-pressure supply shall be such that, should any part of the circuit be put to earth, the leakage current shall not exceed one twenty-fifth of an ampere and one-fiftieth of an ampere for continuous and alternating currents respectively. A maximum percentage leakage would, we think, be a more practical test. In Section 6, again, it is laid down that "the insulation resistance of any high-pressure conductor including joints shall not be permitted to fall below *fifty megohms per mile*." We would suggest to the Board of Trade, firstly, that it would be as well to employ the more rational and correct method of specifying insulation resistance in *megohm miles*; and, secondly, that in adopting such a minimum they are seeking to impose an impossible standard on electric supply companies. At Hastings, for instance, where the standard is rather above than below the average, the product of the length in miles into the total insulation resistance in megohms of any circuit at no time exceeds 3·7 and often falls much below this figure; yet we do not hear either of disastrous short circuits or of fatal accidents. Fifty megohm miles therefore seems to us an absurdly high figure. The clauses relating to the compulsory testing of faulty indoor wiring and to the compulsory cutting off of the supply until such installations are put into proper order cannot but commend themselves to all who wish to see an end put to fires and other mishaps due to careless and cheap wiring. There are several other points in these regulations which call for comment, and we should be glad to have the opinions of those most nearly concerned upon them.

In our advertisement columns will be found an announcement on the part of the Lea Bridge, Leyton, and Walthamstow Tramways Company, which is tantamount to a challenge to electric traction to come and do its best on these suburban lines. The Company is about to invite fresh tenders for the horsing of its cars for twelve months or more, and is prepared to guarantee payment for a minimum mileage of 250,000 to 300,000 miles. Being, however, in the possession of Parliamentary powers to work its system by electricity, the Company announces its perfect readiness to substitute electric for horse traction if an acceptable offer is forthcoming. One or other of the electric companies owning traction patents may, we feel confident, be trusted to take up this challenge.

Digitized by Google

THE New York *World*, with a painful degree of enterprise, has apparently made up its mind to start an electrical scare of its own, and instead, therefore, of devoting its energies to "writing up" the accidents which are reported to have recently taken place in the "Empire City," it has commenced a series of sensational articles on the dangers of electric traction. The following graphic description of a supposititious accident to a Boston electric car will enable our readers to form an idea of the style of this series:—"Suddenly by reason of a slight catch of the trolly-wheel on a point of the overhead wire, the latter falls on the car. . . . A circuit is formed, and we all know what a shock of this kind means. You may picture the stiffened corpses that are removed through doors and windows."

PROF. H. S. CARHART contributed to the *Philosophical Magazine* for November a Paper, which we publish elsewhere, on the construction of the Clark cell. Despite all the work that has been done on this standard of electromotive force, we are still in the dark as to some of the causes of small variations in it. When these doubts are all cleared up, and the process is ascertained of constructing cells absolutely uniform in E.M.F., and the temperature coefficient is accurately known, it will constitute a standard of great utility. At present it just falls short of being perfect.

WILLIAM STURGEON, the inventor of the electro-magnet, is one of those worthies whom every electrician should hold in pious remembrance. We are glad to be able to call attention to a letter in another column of this week's issue from Prof. SILVANUS THOMPSON, in which he asks for information respecting the deceased worthy. Prof. THOMPSON is particularly desirous of obtaining a portrait of STURGEON: we do not remember to have seen one. We trust that there may be some amongst our readers who are in a position to furnish a clue. STURGEON was a Lancashire man, and doubtless there are those still living both in London and in Manchester who knew him personally.

AN esteemed correspondent writing from Madeira reminds us of an unfulfilled duty which we ought to have discharged long ago. It appears that some remarks of ours relating to the suggested use of the telephone in America as an adjunct of the Confessional were so worded as to give pain to members of the Roman Catholic Church; and our attention was called to the fact soon after the occurrence, but in a letter of such unusual length that we have never yet been able to find room for it. As the incident is now more than twelve months old, we can do no more, but at the same time no less, than frankly admit that the note complained of was unfortunately, but unintentionally, open to the construction put upon it. Our correspondent furnished a long and convincing list of Roman Catholic divines and laymen—Volta among the number—who have been devoted to scientific pursuits, together with abundant evidence that the Church is not hostile to scientific progress as such. Obviously the objection to telephonic confession would be on practical or disciplinary grounds, not because the medium was a scientific appliance.

THE amalgamation of the UNITED ELECTRICAL ENGINEERING COMPANY and Messrs. J. G. STATTER and Co., under the title of the Electrical Engineering Corporation (Limited), is another satisfactory sign of the times, since it has been mainly effected with a view of enabling the two firms to cope with their daily increasing volume of business. The works of the Corporation at West Drayton are admirably situated in many important respects, and we anticipate the best results from the fusion of two such energetically managed concerns.

Barmen.—An electric tramway will shortly be constructed between Elberfeld and Barmen.

New Books.—M. Hospitalier has begun the publication of a work in two volumes, entitled "Traité Elémentaire de l'Energie Électrique."

Southampton.—The Town Council have decided to oppose the Provisional Order of the South of England House-to-House Electricity Company.

Harrogate.—The Town Council have decided to oppose the application of the National Electric Supply Company for a Provisional Order.

Ayr.—The Town Council have obtained a Provisional Order for lighting the Burgh with electricity. A committee is considering the subject.

The Davy Medal.—The Davy Medal has been awarded to Dr. W. H. Perkin for his researches on magnetic rotation in relation to chemical constitution.

Weybridge.—Considerable dissatisfaction is felt with regard to the electric light wires and posts, and an agitation is on foot for putting the wires underground.

The Tudor Accumulator.—The *Börsen Courier* learns that the Allgemeine Electricitäts Gesellschaft, Berlin, has purchased the Tudor Accumulator Manufactory at Hagen.

Coventry.—At the last meeting of the Town Council it was decided to oppose the application of the Midland House-to-House Electricity Company for a Provisional Order.

Berlin.—According to the Berlin correspondent of the *Standard*, Herr Werner Siemens intends shortly to retire from business, in order to devote himself entirely to scientific work.

The Telegraph in Afghanistan.—The Amir purposes, says *Indian Engineering*, to open telegraph lines from Kabul to Kandahar, Kandahar to Herat, and Herat to Mazrsharif probably.

St. Marychurch Local Board.—The Devon and Cornwall Electricity Supply Company will not proceed with their Provisional Order covering the area within the jurisdiction of this Board.

Cardiff.—At the last meeting of the County Council resolutions were passed objecting to the applications of the Brush Electric Engineering Company and the Western House-to-House Electricity Company.

Royal Visit to Canford House.—In view of the visit of the Prince and Princess of Wales, Canford House has been redecorated and provided with the electric light, over 1,000 lights having been put in.

The St. Petersburg-Moscow Telephone Line.—The trunk wire connecting St. Petersburg and Moscow was completed a few days ago, and although it is of iron, satisfactory results are reported to have been obtained.

The Western and Brazilian Company and the Brazilian Republic.—The *Rio News* of December 23rd states that the Western and Brazilian Telegraph Office was under official control from the 18th to the evening of the 20th.

Walsall.—At the meeting of the Town Council on Monday the General Purposes Committee reported that they had caused the common seal to be affixed to the memorial to the Board of Trade for the Electric Lighting Provisional Order.

Digitized by Google

Melbourne.—The rapid extension of electric lighting at Melbourne has caused the insurance companies to take into consideration the promulgation of rules and regulations with regard to electric light installations in Victoria.

The Electric Light in New Zealand.—The town of Lawrence (New Zealand) is to be lighted by electricity. The price charged for the light to consumers is not to exceed what would be equivalent to 6s. 8d. per thousand cubic feet of gas.

Telegraphic Communication with Martinique.—The contract with subsidy entered into between the West India and Panama Telegraph Company and the island of Martinique, which expired on December 31, 1889, has been renewed for one year.

Dockyard Central Stations.—Following the example of the Admiralty, the French Minister of Marine has directed the dockyard officials to draw up plans and estimates for the erection of central lighting stations in the various dockyards of France.

Leamington.—At the meeting of the Town Council the report of the Watch Committee, which was in favour of a deputation being appointed to visit a number of towns with the view of recommending the best system of lighting, was adopted.

Royal Society.—Since the last anniversary of the Royal Society 24 memoirs have been published in the Philosophical *Transactions*, containing a total of 753 pages and 33 plates. Of the *Proceedings*, 12 numbers have been issued, containing 1,062 pages and six plates.

Electric Lighting Tenders.—Tenders, which must be sent in by February 1st, are invited for the public lighting of Wildungen by gas or electricity. The Municipality of Berne also invites tenders for the electric lighting of the town; the tenders to be sent in by February 15th.

The Metropolitan Provisional Orders.—The Electricity Supply Corporation have abandoned their Paddington Order. The same Corporation have also abandoned their proposed Order for the lighting of the district of St. Giles' District Board of Works and the district of the Strand Board of Works.

Atlantic Cables.—The steamship "Faraday," has reached the Thames, after successfully laying two cables from Nova Scotia to New York for the Western Union Telegraph Company, and repairing the fracture in one of the main Atlantic cables. The second task was performed on the last day of 1889 in stormy weather.

Extension of the Oerlikon Works.—The Oerlikon Electrical Works are about to undergo considerable extensions, and it is proposed to obtain motive power from Burlach, twenty kilometres distant. According to *La Lumière Electrique*, an alternating current at a pressure of 25,000 volts is to be employed for the purposes of transmission.

Sunderland.—The Corporation have decided to oppose the Provisional Order of the Newcastle and District Electricity Supply Company, the basis of the opposition being the amount of capital to be deposited, the area of supply, the period within which the works are to be completed, and the control over the streets exercised by the company.

Personal.—Mr. J. Carruthers Allan has been appointed superintendent for the African Direct and West African Telegraph Companies at Bonny, West Coast of Africa, and has resigned his position of Danish Consul for the Colony of Lagos. He has been succeeded in that appointment by Mr. S. J. Boffa, who is at present representing the first-mentioned company at that place.

Brussels.—At a recent meeting of the Communal Council, M. Janssen announced that the electric light would be installed in Brussels by the end of the present year. The Council will reserve for its municipal station a zone of a quarter of a mile radius from the Market-place. The area comprises nearly all the theatres, the largest shops, as well as the central boulevards.

Royal Meteorological Society.—The annual meeting of this Society was held on Wednesday evening. The Council in their report stated that the total number of Fellows is 550, being an increase of 25 on the previous year. Mr. Baldwin Latham, M.Inst.C.E., was elected President for the ensuing year, and the retiring president, Dr. Marcet, then delivered an address on "Atmospheric Dust."

The Despatch of Cablegrams by Mail Steamers.—The Eastern Telegraph Company has made arrangements with the English Post Office authorities by which cablegrams will be received at the Mauritius Post Office, and despatched by the mail steamers to the nearest cable stations. A similar arrangement is being negotiated with the French Government in respect to Réunion and Tamatave.

The Provincial Electric Lighting Orders.—The National Electric Supply Company have, it it understood, decided not to proceed with their Barnsley Order, thus leaving the Order deposited by the Corporation of Barnsley unopposed so far as that company are concerned. The same company have also dropped their proposed Order for the electric lighting of Hull, for which the Corporation have deposited an Order with the Board of Trade.

Marylebone Vestry.—At a meeting of this Vestry last week it was agreed that notice should be given to the Metropolitan Electric Supply Company that where vaults exist under the footway pavements of any of the streets of the parish, the mains of the company shall be laid only in the roadway of such streets; and, further, that the company must deposit a sum of 2s. in footway and 3s. in roadway per lineal yard wherever operations are commenced.

Exeter.—At the last meeting of the Town Council Councillor Varwell moved, "That in view of the serious nature of the report presented by the surveyor and fire superintendent as to the overhead electric lighting cables, and the imperilling thereby of the public safety, the Electric Lighting Company be informed that the Council cannot consent to any further extension of their overhead wires." After a lengthy discussion the motion was lost by 22 votes to 10.

St. George's (Hanover-square) Vestry.—At the last meeting of this Vestry the Electric Lighting Committee recommended the Vestry to petition against the London Central (Subway) Railway Bill, in order to obtain a *locus standi*. An amendment was moved that the Bill should be opposed by counsel. After a long discussion the amendment was carried by 30 votes to 19. Another amendment to refer the matter back to the committee was negatived by a large majority.

Newcastle.—At the last meeting of the Town Council, the Town Improvement Committee presented a report relative to an application by the Northern House-to-House Electricity Company, for a Provisional Order. The committee did not think it desirable that a third company should supply electricity in Newcastle. It was agreed that objection be lodged with the Board of Trade. The Newcastle and District Electric Lighting Company have commenced to supply current.

Dundee.—At the last meeting of the Police Commission the application of Mr. Caird for permission to erect an overhead electric wire from Ashton Works to his house in Magdalen Yard-road was considered. The question was discussed at great length. The Lord Provost and several members were in favour of granting the request, since the current was only to be at a pressure of 50 volts. It was, however, finally decided by 13 votes to 10 to refuse the application.

Reading.—Mr. Yeatman, local manager of Messrs. Laing, Wharton, and Down, having agreed to light by electricity the Free Library and Museum for a sum less than the gas lighting has hitherto cost, the Town Council have authorised the Library Committee to close with the offer, and the installation will be proceeded with without delay. In business houses electricity is being widely adopted as an illuminant, the number of installations being so great that Messrs. Laing, Wharton, and Down have had to supplement their original plant by extensive additions. The 1,200 candle-power arc lamp is almost exclusively used.

Hertford.—At a recent meeting of influential gentlemen resident at Hertford, held under the presidency of the Mayor, the subject of initiating a scheme for supplying the electric light in the borough was discussed. It was suggested that a company should be formed, with a capital of £20,000 or

Digitized by Google

£25,000, to carry out the scheme; and this was eventually agreed to—a committee being nominated to take the necessary steps in the matter. It was stated that the required capital could be easily obtained; and, with regard to the possible success of the undertaking, it was confidently expected that most of the tradesmen in the town would take the light.

The Lighting of the City.—At the meeting of the Commissioners of Sewers on Tuesday, the clerk submitted an application of the London Electric Light Corporation for the Commissioners' consent to their application for a Provisional Order; also a similar application from the Metropolitan Electric Supply Company. Mr. Innes moved that these applications do lie on the table. He said they had already settled the matter so far as the Brush Company was concerned, and they had given them a contract to carry out the electric lighting on the terms arranged by the Streets Committee. It would be most unfair to the contracting company if they agreed to these fresh applications seeking Parliamentary powers over the City. The Commissioners must be masters in their own place. After some discussion Mr. Innes' motion was agreed to almost unanimously.

Old Students' Association.—On Wednesday, January 29, at 8 p.m., a special general meeting of this Association will be held at the Central Institution, Exhibition road, for the consideration of certain important changes in the rules. In their fourth annual report the committee state that the register now embraces 194 names—honorary members 7, members 158, associates 29. During the past session 61 new names have been added—43 members and 18 associates. On June 25, 1889, the following resolution was unanimously passed by the committee:—"That Prof. John Perry, F.R.S., D.Sc., be, and hereby is, elected an honorary member of the City and Guilds of London Institute, Old Students' Association, as some slight recognition of the strong and unremitting interest he has manifested in the affairs of the Association since its inception." The committee further report that there are usually more vacancies than applicants on the employment register. The Papers read before the Association were examined by Profs. Unwin, Henrici, and Armstrong, and the Medal of the Association was awarded to Mr. Heller for his Paper on "Aluminium." The accounts of the Association show a satisfactory balance.

Obituary.—It is with deep regret that we record the death, on December 26th, of Mr. Jean François Despointes, whose name is well known in submarine telegraph circles. Mr. Despointes was born on November 4, 1816, at Barfleur. He came to England at the age of 20. In 1854 the then chairman of the Submarine Telegraph Company offered him the post of translator to the company. In 1858 he was made superintendent-in-chief, a post which he occupied without intermission until his death. Mr. Despointes took a great interest in all that related to scientific progress, and from his position in the Submarine Company he was constantly brought into connection with those desirous of making experiments upon submarine lines. It was in this way that he was able to afford considerable assistance to Sir Charles Wheatstone, Prof. Hughes, Dr. Muirhead, M. Baudot, and others. In 1864 he assisted in the experiments made by the Russian Government between Caucasia and Valentia, Ireland. He was a member of the Institution of Electrical Engineers, the Society of Arts, the Société Internationale des Electriciens, and numerous other societies in England and France.—The death is also announced of Mr. Charles Henry Chadburn, founder of the well known firm of Chadburn and Son, telegraph manufacturers, of Liverpool. Mr. Chadburn took an active part in the business up to the time of his retirement a few years ago.

The Glasgow Corporation and Overhead Wires.—At the last meeting of the Town Council, a minute was submitted from the Special Committee on Overhead Electric Light Cables and Wires. It contained a report on the subject from Messrs. John Carrick, master of works; William Paterson, inspector of fires; and David Cook, electrical engineer. From this report it appears that there exist at present in Glasgow 3½ miles of overhead conductors carrying high-pressure alternating currents, and 1¾ miles of overhead conductors carrying low-pressure continuous currents. The report concludes as follows: "We would, however, fail in our duty were we not to express in the strongest manner possible our conviction that the present methods of conveying the currents overhead are such as to expose the citizens to serious risks of life and property, and that some change upon the existing arrangements should be effected without any delay." The Committee, having considered the report, agreed that it was necessary to take steps to bring the circumstances under the notice of the Board of Trade, and to urge on the Board the adoption by them of the procedure for the protection of the public safety under the Electric Lighting Acts. The Clerk was also directed to intimate to Messrs. Muir, Mavor, and Coulson (Limited) that the Magistrates and Council have had this matter under consideration, and had communicated with the Board of Trade in reference thereto. The minutes were approved.

The Penny Postage Jubilee Dinner.—At the Penny Postage Jubilee Dinner on Wednesday evening Sir Lyon Playfair, in the course of his speech, alluded to the late Mr. Scudamore in the following appreciative terms:—"On a day of rejoicing and remembrances like this let me say a word of appreciation of one of the greatest and best officials in the history of the Post Office—I allude to the late Mr. Scudamore. When I entered upon my duties as Postmaster-General he was in official difficulties with the Treasury and Parliament, because in his zeal he had used the revenue of the department for the rapid extension of the system of telegraphs. Of course, this was a grave official error, for the money ought to have been voted by the House of Commons. I entered the office believing that I would have much trouble with this impetuous secretary, but I left it feeling the highest admiration of his administrative capacity and unselfish zeal. The country owe him a debt of gratitude for the rapid and efficient extension of the telegraphic system. One night of anxiety remains vividly in my memory. The new Post Office buildings, with their fine telegraphic halls, were ready, but it was an anxious thing to disconnect the whole telegraphic communication of the country and re establish it in the new building. Mr. Scudamore was equal to the occasion, and the change was made without the loss of a single message or more than one hour's delay. Like so many of our friends Mr. Scudamore has gone to the great majority, but his memory should not be forgotten on this occasion."

Bradford.—At the meeting of the Corporation on Tuesday, a resolution was included in the minutes of the Gas and Electricity Supply Committee, authorising the present expenditure of a sum of £10,000 in extending electric light works, and appointing Mr. Sydney Baynes managing engineer at a commencing salary of £250 per annum.—Alderman Fred. Priestman, in moving the adoption of the minutes, reminded the Council that some few weeks ago the committee obtained permission to secure additional borrowing powers to the extent of £30,000. When they started the installation at the end of September they had only demands for 330 amperes, but they were now supplying 1,520 amperes. This had exceeded the most sanguine expectations of the members of the Council. They had now increased demands which they could not grant, as already the apparatus was somewhat overstrained. This being the state of affairs the committee was anxious that before next winter they should be able to supply the demand. Besides the outside application they had also had a requisition through the Mayor from the Recorder asking that the electric light should be placed in the Borough Court, and the School Board also required it. The buildings erected were sufficient for supplying four times more current than they did at present, and consequently the fixing of further apparatus would go towards making the system pay. At present they charged 5d. per unit for the electric light, but if that did not pay it would be their clear duty to increase the price.—Mr. Galloway opposed the resolution. He said that when the electric lighting scheme was first mooted the expenditure was to be limited to £20,000, but now another £10,000 was to be spent, and there was a further £20,000 in the background. He thought the committee should stay their hands until the experiment had been fairly tried, and it were seen if it were a financial success.—The minutes were adopted.

Digitized by Google

MAGNETISM IN IRON AND OTHER METALS.*

BY PROF. J. A. EWING, F.R.S.

III.

(*Continued from page 212.*)

§ 12. **Magnetic Force within the Metal.**—The magnetic force due to external causes—that is, to magnets or electric currents in the neighbourhood—which has just been described as constituting one part of the magnetic force which we should measure in a crevasse, is to be thought of as acting also within the uncut substance of the metal itself. It constitutes the whole magnetic force there. We shall denote the magnetic force by **H**. We must bear in mind that in reckoning the value of **H** at any point within the substance of a piece of magnetised metal, we have to take account not merely of the forces due to electric currents and to terrestrial magnetism and to the poles of other magnets, but also the forces which are contributed by the poles of the piece itself with which we are dealing.

§ 13. **Magnetic Induction.**—The whole group of lines which cross the crevasse is to be conceived as existing within the metal before the crevasse was cut, partly as lines of magnetisation and partly as lines of force. The whole group of lines which cross the imaginary crevasse consists (per square centimetre) of the resultant of $4\pi\mathbf{I}$ and **H**. This resultant is called the *magnetic induction* within the metal, and is denoted by **B**. The quantities $4\pi\mathbf{I}$ and **B** are vectors, having direction as well as magnitude, and are to be compounded as forces or velocities are compounded. If **H** and **I** happen to have the same direction, **B** is numerically equal to the sum of $4\pi\mathbf{I}$ and **H**. In any case the equation

$$\mathbf{B} = 4\pi\mathbf{I} + \mathbf{H}$$

is true when understood in the vector sense, that **B** is the resultant of $4\pi\mathbf{I}$ and **H**. In most of the cases that are of practical interest **H** has either the same direction as **B** or it has the opposite direction, so that the above equation holds good in the numerical sense when the proper sign (+ or −) is given to **H**, according as it assists or opposes the magnetisation.

§ 14. **Distinction between Magnetic Induction and Magnetic Force within the Metal.**—The lines of magnetic induction (**B**) within the bar are continuous with the lines of magnetic force in the space outside—that is to say, every Line of Force outside is completed, so that it forms a closed curve, by a Line of Induction inside. For many purposes **B** is the most important quantity by which the magnetisation of a magnet may be specified. In a dynamo, for instance, it is in the value of **B** in the armature core that determines the strength of the magnetic circuit. The analysis of **B** into two components, **H** and $4\pi\mathbf{I}$, is no doubt highly artificial, but it is of service when we have to deal with the relations which exist between the magnetism of a magnet and the influences which are affecting its magnetism from outside. The student will find it useful to picture to himself the state of a magnet at any point of its substance by thinking of two groups of lines as passing through the metal, namely, $4\pi\mathbf{I}$ and **H**, which combine to form a resultant group **B**. To obtain **B** directly we have only to imagine a narrow crevasse cut across the magnet: **B** is measured by the force a unit pole would experience if placed in such a crevasse; in other words, it is the number of lines which cross the crevasse per square centimetre of cross-section. If, on the other hand, we wish to isolate the magnetic force **H** that acts at any point within the metal, we may imagine a hole drilled through the magnet from end to end in the direction of magnetisation, and passing through the point at which **H** is to be measured. The force which a unit pole would experience if placed in the hole at that point is **H**. That this is so will be evident when it is remembered that there is no free magnetism on the sides of the hole, because it is supposed to be drilled in the direction of magnetisation, and the force within it is, therefore, due solely to the outside influences which give rise to the magnetic force **H**, as defined in § 12, namely, the free magnetism at the ends of the magnet and any other magnets or currents that are near.

* All rights are reserved.

§ 15. **Particular Cases.**—The following illustrations may help to make these definitions intelligible. Take a ring electro-magnet consisting of an iron core, wound with a solenoid of n turns per centimetre, and let a current, C, flow in the solenoid. The magnetic force within the solenoid, due to this current, is approximately equal to $4\pi\mathrm{C}n$ at all points. If there are no neighbouring magnets or other sources of magnetic force, this is the value of **H** which acts on the metal of the ring. Next, let the ring be cut and straightened into a bar, with the solenoid still on it, through which the current C flows. The magnetic force due to the current is still sensibly equal to $4\pi\mathrm{C}n$ (except near the ends). But we now have another term to consider in reckoning **H**. The free magnetism residing at the ends of the bar produces magnetic force at all points in the interior, as well as at points in the space outside, and **H** is the resultant of this force, together with the force $4\pi\mathrm{C}n$ due to the current. The force due to the free magnetism at the ends is opposite in direction to that due to the current; hence **H** at any point within the metal is less than $4\pi\mathrm{C}n$ by an amount which depends on the distance of the point considered from the ends of the bar. The longer the bar is the more nearly will **H** be identical with $4\pi\mathrm{C}n$, and if the bar is very long, so that the ends are too far removed to have any material influence, we may take the magnetic force on central portions as sensibly equal to $4\pi\mathrm{C}n$.

Again, in a permanent bar-magnet there is at any point a certain magnetic force, **H**, due to the free magnetism at the ends, and opposite in direction to the lines of magnetisation within the metal. We may call this the *self-demagnetising force exerted by the bar*, since its tendency is to reduce the bar's magnetisation.

Again, a long piece of straight iron wire stretched in the direction of the lines of force of the earth's magnetic field is acted on by a magnetic force, **H**, equal to the force of the earth's field. If the wire is hung vertically it is convenient to treat the earth's field as consisting of a horizontal and a vertical component. The former is a magnetic force which acts across the wire; the latter is in this case much the more important of the two, for it constitutes the whole longitudinal part of the magnetic force **H**, and, as we shall presently see, it is upon this almost wholly that the magnetisation of the wire depends.

§ 16. **Magnetic Permeability.**—In general, when a substance is placed in a magnetic field it becomes magnetised. We may express the connection between the magnetism it acquires and the magnetic force which acts upon it in two ways.

One of these ways is to compare the magnetic induction **B** which is produced in the metal with the magnetic force **H** to which that induction is due. For most purposes this is the best way.

To fix the ideas let us think of a very long uniform rod placed in a uniform field of magnetic force, with the direction of its length parallel to that of the lines of force. When the rod becomes magnetised its ends disturb the field of force, but we can get rid of any trouble about the ends by thinking of the rod as indefinitely long, or so long that the influence which the ends have on the value of the magnetic force is negligible. Let the uniform magnetic field exert a certain force, **H**, on the rod. This produces within the rod a certain induction, **B**, the value of which might be measured by cutting a narrow crevasse across the rod at any place, and measuring the number of lines per square centimetre which cross the crevasse.

If the rod is of iron, nickel, or cobalt, it will be found that the number of lines of induction **B** per square centimetre within the rod is much greater than the number of lines per square centimetre in the field. This fact may be expressed by saying that the material of the rod is more *permeable* by lines of magnetic induction than is the space or medium surrounding it. In Faraday's expressive language, the material of rod has greater conductivity for the lines of induction than the surrounding space or medium has. We may think of the lines as crowding by preference into the rod, finding an easier path through it than through the surrounding medium.

The quality in virtue of which the material of the rod conducts the lines better than empty space conducts them, is called its *magnetic permeability*. This phrase was introduced by Sir William Thomson in his mathematical development of the subject, as a

Digitized by Google

synonym for Faraday's "Conducting power of a magnetic medium for lines of force."

In the case we have supposed, of an indefinitely long rod, the magnetic force at any point within the metal has the same value as the magnetic force at any neighbouring point in the space outside, since the force is not disturbed by the magnetisation of the rod. In such a case we might define the permeability as the number (per square centimetre) of lines of induction **B** in the rod to the number (per square centimetre) of lines of force in the space outside. But if we wish a definition which will be of more general application—applying to short rods as well as to long ones, and to other forms of magnet—we have to bear in mind that the surrounding field is generally disturbed by the magnetisation of the piece. What has to be compared is the induction at any place in the metal with the magnetic force which is in operation there; in other words, we may define the permeability as the ratio of the induction **B** at any point of the metal to the magnetic force **H** which acts within the metal at that point. The permeability is usually denoted by μ; so that we have

$$\mu = \frac{\mathbf{B}}{\mathbf{H}}.$$

In this definition it is to be understood that **B**, the magnetic induction, has been produced by subjecting the material to a magnetic force, **H**.

§ 17. **Permeability of Paramagnetic and Diamagnetic Substances.**—A paramagnetic substance is one in which the permeability is greater than that of empty space. In other words, when such a substance is placed in a magnetic field it will become magnetised in such a way that **B** is greater than **H**. The lines of force of the surrounding field will converge more or less towards it, preferring it to the neighbouring space as a magnetic "conductor." Iron, nickel, and cobalt are paramagnets with exceedingly great permeability.

In a diamagnetic substance, on the other hand, the permeability is less than that of empty space. When such a substance is placed in a magnetic field, the lines of force more or less avoid it as a bad "conductor," preferring the space outside. No substance is more than slightly diamagnetic Even in bismuth, which is the most highly diamagnetic substance known, the magnetic permeability is very little less than unity: its value is about 0·9997.

The permeability of air is sensibly the same as that of empty space. Hence, when a magnetic field is formed in air, the lines of induction are indistinguishable from the lines of force. It is only when the lines pass into a substance which is either paramagnetic or diamagnetic that the distinction between magnetic force and magnetic induction must be maintained.

§ 18. **Illustrations of Permeability.**—By way of illustrating the behaviour of paramagnetic and diamagnetic substances when placed in a magnetic field, Fig. 5 and Fig. 6 have been copied from one of Sir William Thomson's Papers.* In Fig. 5 a magnetic field which was originally uniform has been disturbed by having placed in it a sphere of exceedingly permeable material. Before the sphere was placed in the field the lines of force were straight, parallel, and equally spaced. The effect of introducing the sphere is to make them converge upon it in the manner which has been exactly represented in the figure from which Fig. 5 is copied. Outside the sphere the lines may be called indifferently lines of induction or lines of force (§ 17). The lines inside, which have been added in this copy, are continuous with them, and are lines of induction. The magnetic induction within the sphere is uniform. Fig. 5 may be taken to represent what happens when a homogeneous spherical ball of soft iron is placed in an originally uniform magnetic field.

Fig. 6 shows in the same way how an originally uniform field of force is disturbed by the introduction of a sphere of diamagnetic material. The material here is a purely imaginary one, with permeability barely one-half that of the surrounding medium, and is more highly diamagnetic than any actual substance.

The student will not fail to notice that the convergence or divergence of the lines of induction, illustrated by these typical cases, depends on whether the permeability of the body is greater or is less than the permeability of the medium in which it is placed. If the surrounding medium were itself a paramagnetic substance, the case shown in Fig. 6 might be realised by choosing for the material of the spherical ball a substance whose permeability was about half (more exactly 0·48 times) that of the substance surrounding it.

We shall return to these figures later, in speaking of the influence which the form of the body that is placed in a magnetic field exercises on the amount of magnetic induction within the body.

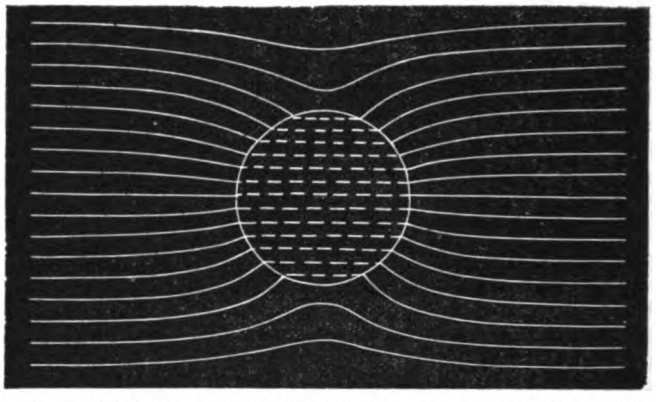


Fig. 5.—Disturbance of an originally uniform magnetic field by the introduction of a soft iron sphere.

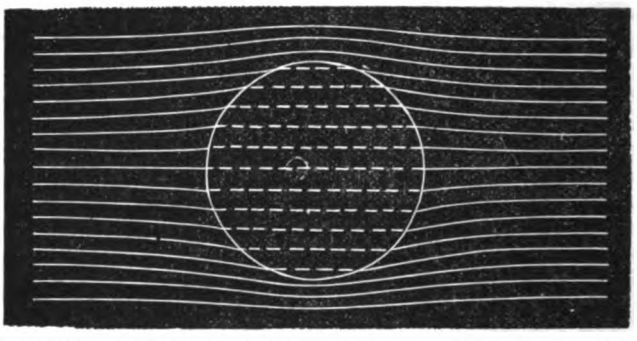


Fig. 6.—Disturbance of an originally uniform magnetic field by the introduction of a sphere of some diamagnetic material.

§ 19. **Magnetic Susceptibility.**—When a substance is magnetised by subjecting it to the action of magnetic force, the relation of the induction **B** to the force **H** measures, as we have seen, the permeability of the substance. But instead of expressing the magnetisability of the substance by stating the relation of the induction **B** to the force **H**, we may state it in a different way by giving the relation of the intensity of magnetisation **I** to the force **H**. The ratio of the intensity of magnetisation to the magnetic force producing it is called the *magnetic susceptibility* of the substance, and is usually denoted by κ; thus

$$\kappa = \frac{\mathbf{I}}{\mathbf{H}}.$$

(To be continued.)

* Reprint of Paper on "Electrostatics and Magnetism," pp. 489 and 491.

UNDERGROUND MAINS.

BY G. L. ADDENBROOKE.

To the electrical engineer this is probably the most interesting subject of the day, but at the same time, though it may seem paradoxical to say so, it is not a very popular one. A certain amount of thought spent in designing dynamos, switches, and other kinds of electrical plant, will often produce an impressive result; but a great amount of thought spent on underground mains, even if productive of useful work, will usually fail to attract very much attention. It is one of those subjects which is chiefly approached by those who have to face it, not by those who choose it because they like it. Underground mains

Digitized by Google

up to the present have not been an easy subject to write about, and with a few exceptions all the information we have concerning them of a practical nature is fragmentary and disjointed. Such descriptions as have appeared of different systems when of any length and detail, have chiefly been of what inventors proposed to do, and not of what has actually been achieved.

Yet underground conductors are things which need the closest observation and scrutiny in all their details, though, unfortunately, they are by no means easy to observe and scrutinise. The laying of underground mains successfully needs an alert and instructed mind, but it is a class of work which such minds as a rule do not hanker after, and there can be little doubt that a good deal of the ill success which has attended the use of underground mains and conduits so far has been due to the laying of them having been left in hands which were not fully alive to the needs of the case. Once a system has been successfully carried out and has stood the test of time, its further use becomes in a large measure a matter of routine, but while the system remains in a tentative state, intelligent supervision and observation of even the minutest details are a matter of great moment.

The whole subject of underground mains is one of innumerable details rather than of a few broad principles. Each of the systems which have been devised gets over some difficulties well, and is less successful in respect of others; there are weak points in every system, and it is therefore important not to condemn outright any method of laying underground mains, because it has failed in some particular, since it is probable that a modified method of going to work on this point may still lead to success. Again, we must beware of thinking that there is one system of underground mains which must be the best. If there were one system of distributing electric current at one potential, no doubt some one system of conduits and mains would be found most suitable, but at present we are distributing current at different voltages for different purposes, and it is not to be supposed that any one system will prove the best for all these purposes.

Though we may calculate with certainty that as we become more familiar with the control of the current in large quantities, and under commercial conditions, the general tendency will be towards the use of higher voltages, yet we are now settling down by a gradual process of evolution to a fairly defined set of pressures at which current will be distributed in towns. The voltages which we are settling down to use now, and which, since the commercial interests involved are getting large, will not readily be changed, are as follows:—

1. 220—250 volts continuous-current supply at low pressure, using the three-wire system.

2. 500 volts continuous. A pressure which is being found very suitable for tramway working, and for use with motors, and which, though less used at present than the other pressures, seems not unlikely to be more employed in the future, particularly if a good 220 or 250 volt lamp should be discovered, which is by no means impossible.

3. 1,000 volts alternating. The American standard for distribution with transformers, and also the standard adopted by the Metropolitan Electric Light Supply Company (Limited), of London.

4. 2,000—2,500 volts alternating. The European standard for distribution by alternating currents.

5. 2,500—3,500 volts continuous. The general pressure adopted for working arc light systems on a large scale.

6. 10,000 volts alternating. The pressure Mr. Ferranti proposes to use at Deptford for primary distribution, employing two transformers between the central station and the consumer.

It is quite clear that currents at such different pressures as these will require different means for conveying them, and confining them to the conductors. At one end of the series we need a great section of copper, but only a moderate amount of insulation; at the other end of the series the section of the copper is relatively very small for the power conveyed, but the pressure of the current being very great much more elaborate precautions must be taken to insure that the insulation employed will stand the strain put upon it.

Before proceeding directly to describe the methods of constructing underground mains which are finding most favour with electrical engineers at present, it may be worth while briefly to allude to earlier experiences in similar classes of work. Now there are three sources from which we can draw a great deal of information of this kind.

The first is the early history of the mains used for conveying gas. In almost all cases some protection is being used for the conductors which carry the electric current, and in designing these coverings the experience met with in the early days of gas main-laying will stand us in good stead, if carefully noted.

The second and more important source is the experience of the telegraph companies, and, later on, the Post Office authorities with underground conductors. The early telegraph companies went in for underground conductors to an extent that few people who were not of years of discretion at that time have an adequate idea of. This battle of conduits and underground mains was very fully and thoroughly fought out then, and almost all the various constructions which have within the last two or three years been suggested were at that time tried. Most of them failed, or were defective in some particular or other, which caused them to be abandoned. It does not follow that because they failed then, therefore, that they should fail again when tried under better conditions now; but in any case a knowledge of what was found to be their weakness then should lead us to be cautious about that particular point now, and unless we can see that improved construction in this portion is likely to get rid of the defect, to be very careful in using the method.

The third and most important source from which we can draw experience is in the results obtained with the different methods of construction which are already in use by electric lighting companies so far.

When gas lighting was first introduced the manufacture of pipes was in a comparatively crude state, and iron pipes were only just beginning to be used for water, and it was still a moot point how the joints should be made. Small iron pipes were at the time unknown; gun barrels joined together were for some time used as a substitute, and it was a good while before the method of welding up wrought-iron pipes out of hoop iron was invented, and later on their manufacture by machinery. The manufacture of lead pipes also was in a very imperfect state, especially as regards the larger sizes. It was not until a great many experiments had been tried that the present methods of constructing gas mains were finally adopted. Amongst other things both wood and earthenware mains were tried, sheet-iron mains covered with lead, and mains of zinc and smaller pipes of papier maché. Wooden mains could not be kept tight at the joints, and earthenware mains were found to be too inflexible and fragile, though earthenware had an extended trial, and was only abandoned when, in spite of its cheapness, its marked inferiority to iron mains for conveying gas could no longer be doubted.

It is true that in the case of gas the chief object was to prevent the gas leaking out at the joints, while in electric conduits there is nothing of the same nature to leak out; still there is the tendency of water to get in, and this tendency with pipes buried two or three feet would in some places be greater than that of gas to escape, since it is easy to imagine a head of 12 or 14 inches of water trying to get in at the joints when the pipes are buried in ground saturated with water. Some authorities have said, I am aware, never mind about a little leakage, only provide drains to carry it off; but this does not seem to be a wise maxim for practice. From condensation and other causes water has a tendency to get into conduits any way, and if it does not do any actual harm, it lowers the margin of safety. Therefore the less we have of it the better, and the more efficient will be our means of dealing with it if we do not have to cope with large quantities or sudden and unexpected flows.

With respect to the laying of iron pipes and their lasting qualities, there is plenty of experience to guide us, which will be found fully detailed in the manuals used by gas and water engineers. It need only be noted here that iron pipes or ironwork last best when laid in a clayey soil, and worst in a porous soil. When laid in made ground,

Digitized by Google

such as that found often in the suburbs of rising towns, containing ashes and organic refuse, the life is often very short indeed, a pitting action taking place which eats the pipe in holes. This is no doubt due to local electric currents set up. In such cases extra precautions must be taken to prevent this action. The most usual way of meeting the difficulty is to cart sufficient clay from the nearest place where there is a deposit, and lay the pipes in it.

One would fancy that if there were anything better known than another in the arts it would be the behaviour of lead pipes under all ordinary circumstances; and yet it happens that this is a question into which a good deal of uncertainty has been imported by statements which have appeared within the last year or two. Lead pipes buried in the ground have for centuries been used with perfect success for the conveyance of water, and later on for the supply of gas. Hardly any excavation is made in a street without disclosing some such pipes. As a rule, they last perfectly without any protection, but it is, I believe, the universal experience of careful gas and water engineers that, particularly in some soils, and in crowded towns in the neighbourhood of sewers, it is best to protect the lead pipe by a light wood box filled up with pitch; this protects the pipe from outside influence, and in some measure from the pickaxes of workmen. On the other hand, the way lead gets eaten away when employed for sanitary purposes, particularly for soil pipes, is a well-known and never-ending theme with sanitary engineers; this action does not occur where the lead is always entirely covered by solutions containing decaying organic matter, but when it comes alternately in contact with such matter, and then with the air. Almost everyone who has lived in or had anything to do with old houses must have seen or heard of instances of action of this kind; and an extented series of speciments can be seen at the Parkes Museum of the Sanitary Institute. It is easy to imagine that lead pipes laid in a porus damp soil in the neighbourhood of leaky sewer pipes will occasionally show evidences of strong action, but because such an action may occur in a few isolated instances, where precautions have not been taken to avoid it, that is hardly sufficient for condemning the general use of lead for covering electric light cables where it is otherwise found suitable.

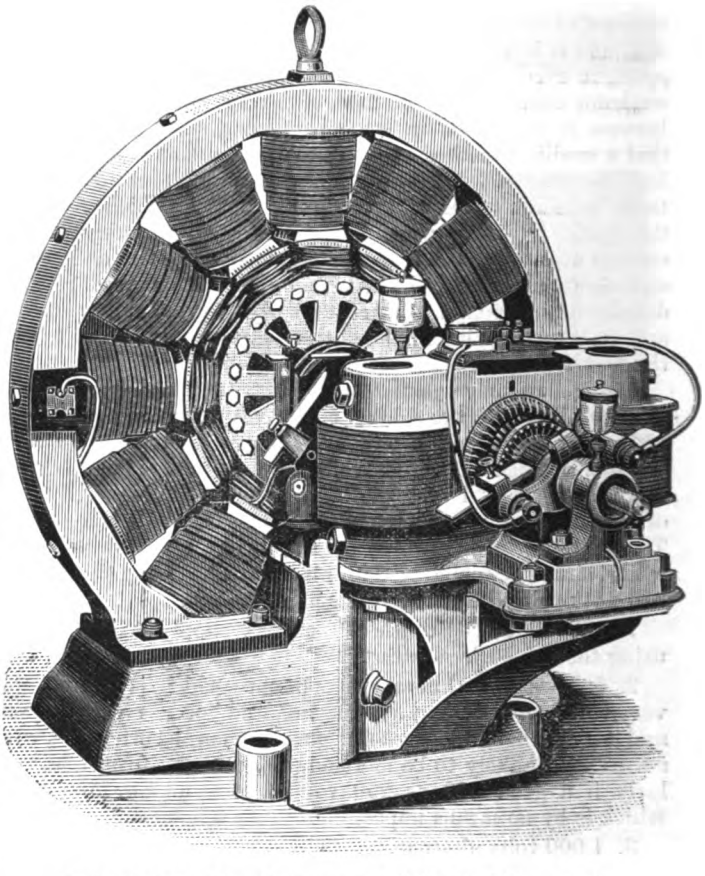
Coming now to telegraphic experience, to those interested in the various experiments tried by the early telegraph companies we would recommend a perusal of the paper read before the Institute of Electrical Engineers in May, 1887, by Mr. Thomas Fleetwood, of the General Post Office. The question is a very practical one, and there is no one who has had a longer and more practical acquaintance with it than Mr. Fleetwood, and therefore what he has to say is well worthy of the attention of those who, in a somewhat different form, have to deal with a very similar set of conditions now. Mr. Fleetwood, in his Paper, gives sufficiently fully the various contrivances used by the telegraph companies, and the reasons, where possible, of the different failures which occurred. Unfortunately, in those days they tried two new things at once, new methods of insulating wires and new forms of conduits. Consequently much of their experience is vitiated, for it is in many instances impossible to tell with certainty if the failures which occurred were due primarily to defects in the conduits or the wires, or whether the imperfection of the conduits put an undue strain on the wires. However, if these early attempts are not satisfactory on the main issues, they, at all events, have furnished a good deal of valuable information on minor points, particularly on the lasting properties of insulating and protective materials.

(*To be continued.*)

Lightning at Ben Nevis Observatory.—The Ben Nevis Observatory has for several days past been cut off from the outer world, the telegraph line having been damaged by the lightning. A lineman from Fort William made the ascent, and found all well. It appears that the flash entered the building by the wire, but that beyond a severe shock none of the inmates were injured in any way.

THE MATHER AND PLATT ALTERNATOR.

We illustrate this week a new alternator, embodying several features of interest, which is now being manufactured by Messrs. Mather and Platt, of Manchester. As is the case with most alternate-current machines in which the armature contains iron cores, the armature revolves and the magnets are fixed. The magnets are wrought iron and are arranged round the armature, exterior to it, and are attached to a massive cast-iron ring, which forms the yoke connecting the limbs. The attachment is so arranged that any of the magnet cores can be removed without disturbing the remainder or taking out the armature. The armature is constructed of two plates or discs keyed on to the shaft, between which the armature cores are held by bolts. As with the magnets, any section of the armature can be removed without disturbing the remainder. Apertures in the discs allow free ventilation in the interior of the armature cores. The magnets are excited by a "Manchester" dynamo, which is carried on a bracket bolted to the bed-plate of the alternator, the armature shafts being coupled direct.



30-Unit Mather-Platt Alternator—1,000 volts, 30 amperes.

The machines are manufactured under the patents of Drs. John and Edward Hopkinson. For working with transformers they are constructed either for 1,000 or 2,000 volts, and from 8,000 to 12,000 alternations per minute, or with a "periodicity" of from 66 to 100. The machines can be run in parallel and may be thrown into parallel working without the least danger, even when there is considerable difference between the electromotive forces at the terminals, or the machines are running at different speeds.

The machine illustrated is for an output of 1,000 volts and 30 amperes at 800 revolutions per minute. The armature resistance is 0·55 ohms, and the resistance of the magnets 2 ohms. When working with full load the current through the magnet coils is 21 amperes, showing an electrical efficiency of over 95 per cent. Messrs. Mather and Platt have already constructed several of these machines for central station work, and have a number now in course of construction.

Digitized by Google

TRANSFORMERS.*

BY HARRIS J. RYAN.

(*Concluded from page 241.*)

The following observations with the secondary on open circuit, and working on one lamp, five lamps, and ten lamps, were made and have been plotted in Figs. 3, 4, 5, and 6; the corresponding curves located by them were drawn in by the scales designated:

Secondary on Open Circuit. See FIG. 3.

Brush Reading.	Primary E.M.F.	Current.	Secondary E.M.F.
21	119	·20	5·5
20	855	·05	62·7
19	1,250	·07	63·4
18	1,420	·11	70·7
17	1,330	·14	66·8
16	900	·19	46·0
15	45	.81	00·0
14	751	·04	37·8
13	1,210	·08	62·0
12	1,390	·12	72·0
11	1,410	·15	72·5
10	1,100	·18	57·8
9	355	·21	14·5
8	645	·08	32·3
7	1·130	·04	57·8
Observed $\sqrt{\text{mean}^2}$.....	1,025	·14	54·5
Calculated from curves $\sqrt{\text{mean}^2}$.....	1,030	·147	53·5

Secondary Closed through One Lamp. See Fig 4.

Brush Reading.	Primary E.M.F.	Current.	Secondary E.M.F.
28	605	·225	31·4
27	330	·125	15·3
26	917	·048	45·2
25	1,300	179	67·6
24	1,403	·215	71·7
23	1,300	·235	67·1
22	820	·239	43·8
21	132	·185	4·7
20	835	·000	3·9
19	1,238	·151	61·5
18	1,420	·215	71·7
17	1,363	·238	68·4
16	1,026	·246	52·7
15	170	·215	9·7
14	793	·048	35·6
Observed $\sqrt{\text{mean}^2}$.....	1,053	·196	52·3
Calculated from curves $\sqrt{\text{mean}^2}$.....	1,021	·190	514·

Mean of ammeter reading, 1·26.

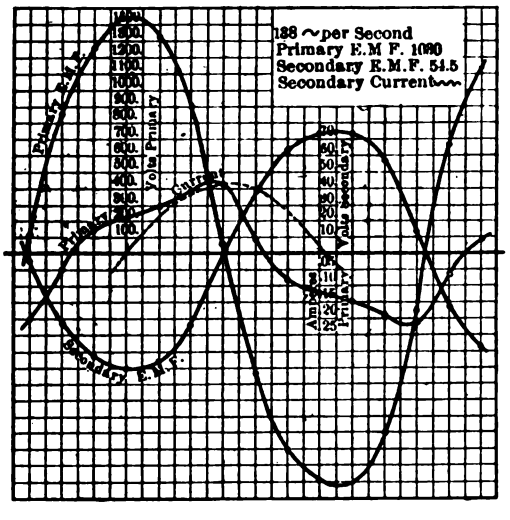


FIG. 3

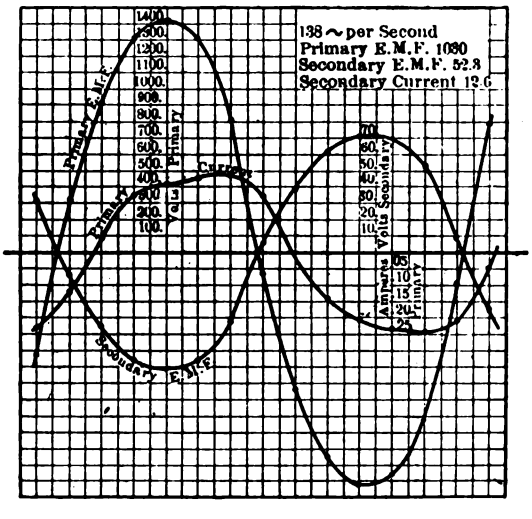


FIG. 5.

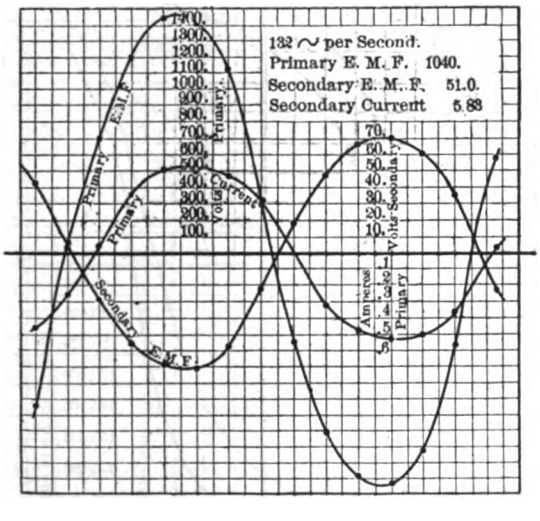


FIG. 4.

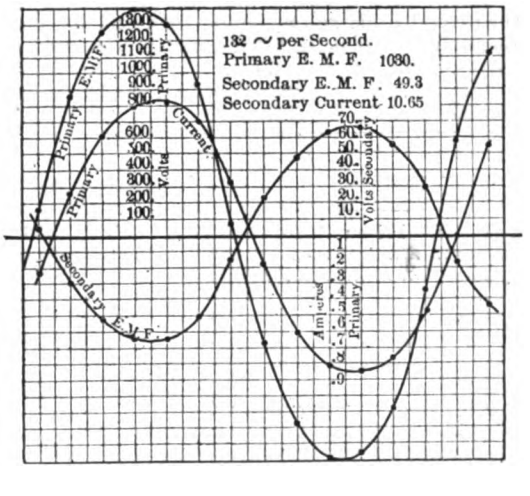


FIG. 6.

* A Paper read before the American Institute o Electrical Engineers, New York, December 17, 1889.

Digitized by Google

Secondary Closed through Five Lamps. See FIG. 5.

Brush Reading.	Primary E.M.F.	Current.	Secondary E.M.F.
29	956	·449	40·3
28	41	·250	10·4
27	723	·000	28·9
26	1,194	·356	54·8
25	1,447	·495	69·1
24	1,350	·483	67·2
23	1,103	·453	57·6
22	293	·304	21·5
21	560	·000	19·8
20	1,110	·318	48·8
19	1,383	·464	65·7
18	1,429	·511	70·0
17	1,228	·500	60·3
16	567	·374	24·0
14·7	585	·030	23·4
Observed $\sqrt{\text{mean}^2}$	1,050	·390	51·0
Calculated from curves $\sqrt{\text{mean}^2}$	1,036	·383	50·6

Mean ammeter reading, 5·83.

Secondary Closed through Ten Lamps. See FIG. 6.

Brush Reading.	Primary E.M.F.	Current.	Secondary E.M.F.
21	138	·242	5·2
20	826	·276	29·7
19	1,237	·642	53·5
18	1,378	·795	64·0
17	1,300	·821	64·3
16	924	·700	51·1
15	63	·340	1·50
14	698	·188	23·7
13	1,138	·587	49·0
12	1,370	·810	63·7
11	1,343	·844	66·0
10	1,073	·771	26·5
9	323	·479	26·5
8	590	·000	17·0
7	1,117	·538	42·8
Observed $\sqrt{\text{mean}^2}$	1,040	·631	49·3
Calculated from curves $\sqrt{\text{mean}^2}$	1,020	·634	49·3

Mean ammeter reading, 10·65.

In Fig. 7 are plotted curves deduced from the foregoing observations that show clearly the rate at which energy is given to the transformer, or that which the transformer restores to the circuit at all points of a complete alternation for the several conditions under which the transformer was operated. The curves themselves show so clearly this particular part of the performance of the transformer that nothing more need be said about them, except to give the percentages of the work given to the transformer that is restored to the circuit by it under the several foregoing conditions :—

Open circuit, 6·8 per cent.	Five lamps, ·96 per cent.
One lamp, 3·9 per cent.	Ten lamps, ·36 per cent.

The above observations and data are ample wherewith to compute the various losses of energy that take place in the transformer under the several loads and under no load, and the deduction of the corresponding efficiencies. These values have been computed, and are given in the following table.

Proper corrections have been applied for the two lamps in series with the primary of the transformer.

—	Secondary open.	One lamp.	Five lamps.	Ten lamps.
Secondary E.M.F.* Primary 1020	5·23	52·3	50·1	47·5
Primary watts	96·1	159·1	388·6	607·9
Secondary watts	0·0	64·3	300·9	525·0
Efficiency	0·0	41·1%	77·5%	86·6%
Total loss in watts	96·1	94·8	87·7	82·9
Hysteresis loss in watts	95·7	93·9	83·1	69·7
Heating loss—				
Primary watts	0·4	0·9	3·3	8·7
Secondary watts	0·0	0·0	1·3	4·5

* The values given have not been corrected for the two lamps in series with the primary for the first three conditions and the one lamp that was used for the last. With 10 lamps, where one lamp was used in the primary this correction amounts to an increase of the secondary E.M.F. of 3 per cent. On open circuit and with one lamp it is negligible, and 3 per cent. increase for five lamps. When this correction is applied, the drop of 3·5 volts obtained is what was observed by direct measurement on the secondary.

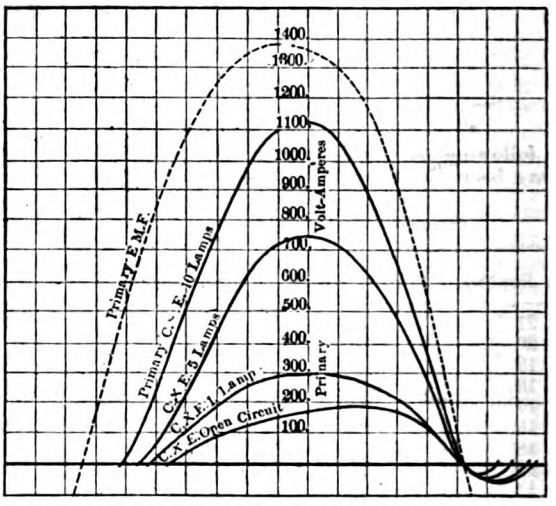


FIG. 7.

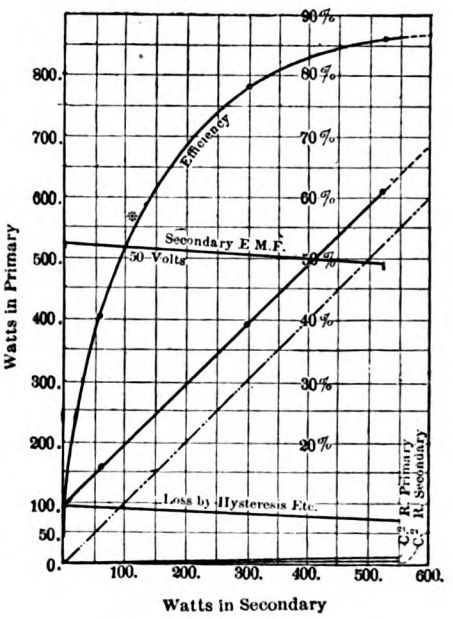


FIG. 8.

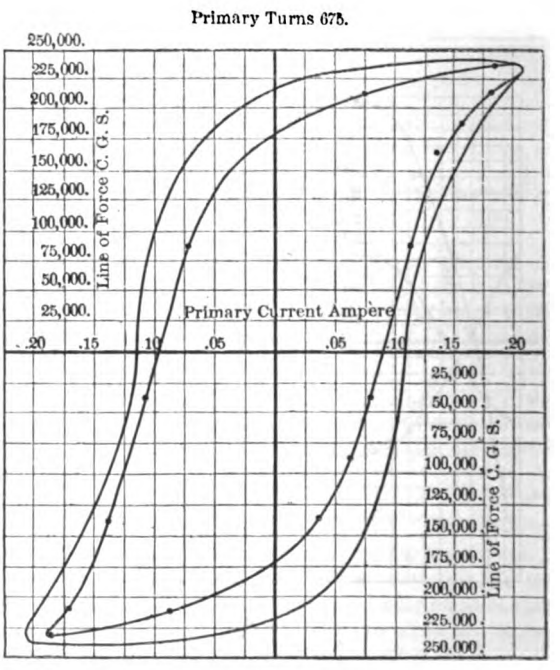


FIG. 9.

Digitized by Google

In Fig. 8 these values have been plotted to scales there indicated, and the respective curves that they determine have been drawn so that one can plainly see the exact performance of the transformer under all loads. It is interesting to note that this transformer might be load to twice its rated capacity, and the heating of the coils would still be less than that of the iron, although the heat produced by the iron grows less as the load comes on. Likewise, that its efficiency would not yet have reached its maximum, and that it would have a value of 92 per cent.

In Fig. 9 the outer curve represents the relation between the magnetising current in the primary and the degree of magnetisation for all points of a complete cycle. The values locating the curve expressing this relation were readily deduced from the observations made when the transformer was working on open circuit. In Fig. 3 the dotted curve represents the curve of primary current that would be found, should Foucault currents be known to be absent, and the relation or ampere turns and magnetisation be the same going up as coming down. Then if Foucault currents were present the dotted curve would have a component at a quarter of a period in advance. This would produce a negative lag in the dotted curve. From the position of the actual primary current it is plainly seen that but a very small component of the above nature is possible, and that the energy that is wasted by eddy currents must therefore be small. The radical departure of the primary exciting current from the approximate sinuous variation of the primary impressed E.M.F. is plainly brought out to be due to *hysteresis*. From the preceding consideration it is also evident that almost the entire advance of the exciting current, and therefore the corresponding dissipation of energy, is due to the same cause.

It was thought of much interest to see what amount of hysteresis would be indicated by carrying the transformer *slowly* through the same cycle of magnetisation that it went at the rate of 138 cycles per second when at work on the circuit with its secondary open. Accordingly, by Ewing's method, modified for the purpose by Dr. Sumpner, Mr. Merritt determined the inner curve shown in Fig. 9. We regret greatly not to have had time for a careful redetermination of this inner curve, and to carry the magnetisation to the same maxima that was done in the transformer when on the circuit. The agreement between the cards would have been more marked even than in Fig. 9.

The assumption made by Mr. Swinburne in his remarkable and valuable Paper on the "Design of Transformers" (*Proceedings* of the British Association, 1889), would therefore be fully substantiated. Mr. Mordey's experiments, in which *hysteresis* and *Foucault current* losses producing a common loss were determined, were performed by cycles of magnetisation produced by rotation, in which the degree of magnetisation did not vary in amount, but in direction, and cannot be said to throw light on the correctness of Mr. Swinburne's assumption. Some, commenting on this Paper, have used Mr. Mordey's results as evidence that these assumptions are wrong. By a knowledge, then, of the magnetic properties of the iron with which a given transformer is to be built, and the methods made use of by Mr. Swinburne, its efficiency is something that can be correctly predetermined.

The importance of making a transformer produce the same E.M.F. at the terminals of the secondary under all loads asserts itself when it is used for incandescent lighting. In the transformer under consideration, from the ratios of the primary and secondary turns, the E.M.F.s that they produced, and the variations of magnotisation that had to take place through the primary in order that the same should produce an E.M.F. equal and opposite to that of the primary impressed E.M.F., the magnetisation produced through the secondary, and the magnetisation set up about the primary in its own air space are determined. In the present transformer this "leakage" of magnetism amounted to about 1·2 per cent. When the transformer works on full load 4·5 times as much current passes through the primary, and the "leakage" of the primary in its own space is 4·5 times as much as an open circuit, and becomes 5·4 per cent. This value, together with the small drop due to the actual resistances of the transformer coils, accounts for the fall of 3·5 volts that was observed by turning on all of the ten lamps. Attention might be called to a similar "leakage" in magnetism that takes place in the secondary circuit. It is plainly brought out in Fig. 6, by the lag of secondary E.M.F. The magnetic "leakage" producing a self-induction is proportional to the secondary current. The rate of change of this quantity, then, is proportional to the E.M.F. that it produces. This E.M.F. is therefore a quarter of a period behind the secondary current and results in producing a small lag in primary and secondary currents and secondary E.M.F. Finally, there is a curious behaviour of this transformer that remains to be accounted for. This is the considerable decrease in the loss by hysteresis, as the transformer is loaded down; that is not to be accounted for by rise of temperature or the falling off of the magnetisation due to the increased "leakage" about the primary in its own air space. The following reason suggested itself to the writer why this should take place. Mechanical shock has been shown to greatly reduce loss by hysteresis when iron is passed through cycles of magnetisation. Since the currents are at all times opposite each other in the two coils of a transformer, strong repulsion occurs when these currents are at a maximum and no force is exerted when they pass through zero. So it follows that they continually keep thrusting each other apart when at work, and add to the disturbance of the laminated iron that already exists on account of its changing magnetisation. This increasing of the mechanical vibration of the iron may therefore account for the above-mentioned phenomenon. On open circuit the maximum magnetisation of the iron per square centimetre was 3,850 C.-G.-S. units. Loss by hysteresis per cycle per cubic centimetre, neglecting Foucault currents, ·046 watts at 138 reversals per second. Coercive force per centimetre of the iron, 2·76 C.-G.-S. units.

In conclusion the writer would say that the data here given show for themselves so clearly the advisability of providing some practical means for breaking the primary circuit of the transformer when not in use, that the strong advice of Mr. Swinburne in concluding his Paper need not be repeated.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To day) FRIDAY, January 17th.

PHYSICAL SOCIETY.

5 p.m. Papers to be read, "On a Carbon Deposit in a Blake Telephone Transmitter." By F. B. HAWES. "On Electric Splashes." By Prof. S. P. THOMPSON, D.Sc. "On Galvanometers." By Prof. W. E. AYRTON, F.R.S.; T. MATHER; and W. E. SUMPNER.

SOCIETY OF ARTS.

5 p.m. Indian Section. Paper to be read, "The India Office Records." By F. C. DANVERS.

MONDAY, January 20th.

LONDON INSTITUTION.

5 p.m. Lecture, "Coal, and what we get from it." By Prof. R. MELDOLA, F.R.S.

SOCIETY OF ARTS.

8 p.m. CANTOR LECTURE II. 1. "The Electromagnet." By Prof. S. P. THOMPSON, D.Sc.

TUESDAY, January 21st.

ROYAL INSTITUTION.

3 p.m. Lecture, "The Post-Darwinian Period." By Prof. G. J. ROMANES, F.R.S.

SOCIETY OF ARTS.

5 p.m. Foreign and Colonial Section. Paper to be read, "Tea, Coffee, and Cocoa Industries of Ceylon." By JOHN L. SHAND.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be further discussed, "Recent Dock Extensions at Liverpool." By GEORGE F. LYSTER, M.Inst.C.E.

ROYAL VICTORIA HALL.

8:30 p.m. Lecture: "To Vancouvers Island and Back." By W. L. CARPENTER.

WEDNESDAY, January 22nd.

CIVIL AND MECHANICAL ENGINEERS' SOCIETY.

7 p.m. Ordinary Meeting. Paper on "The Present Aspect of Electric Lighting in London." By E. C. DE SEGUNDO, A.M.I.C.E.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Paper to be read, "Vision-Testing for Practical Purposes." By R. BRUDENELL CARTER, F.R.C.S.

THURSDAY, January 23rd.

ROYAL INSTITUTION.

3 p.m. Lecture: "Sculpture in Relation to the Age." By EDWIN R. MULLINS.

LONDON INSTITUTION.

6 p.m. Lecture: "On the Shapes of Leaves and Cotyledons.' By Sir JOHN LUBBOCK, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary Meeting. Adjourned discussion on the PRESIDENT'S Address on "Magnetism."

FRIDAY, January 24th.

INSTITUTION OF CIVIL ENGINEERS.

7:30 p.m. Students' Meeting. Paper to be read, "The Up Keep of Metalled Roads in Ceylon." By THOMAS H. CHAPMAN, Stud.Inst.C.E.

ROYAL INSTITUTION.

9 p.m. Lecture: "The Scientific Work of Joule." By Prof. DEWAR, F.R.S.

SATURDAY, January 25th.

ROYAL INSTITUTION.

3 p.m. Lecture: "The Natural History of the Horse, and of its Extinct and Existing Allies." By Prof. FLOWER F.R.S.

Digitized by Google

The Electrician.

Published every Friday. Price Fourpence; Post Free, Fourpence Halfpenny
Editorial, Publishing and Printing Offices:

No. 1, SALISBURY COURT, FLEET STREET, LONDON, E.C.

Telephone No. 2714. Telegrams: "Electrician Newspaper, London."

All Communications to be addressed to "The Electrician," *1, Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "The Electrician."

All letters intended for insertion in "The Electrician," *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

"The Electrician" *is published every Friday morning, in time for the morning mails. Subscribers should receive their copies by the first post on Friday morning.*

"The Electrician" *is on sale at the railway bookstalls throughout the United Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices as above.*

SPECIAL NOTICE.

Owing to the increase in the number of pages of "The Electrician," in order to partly cover the increased postage, we have been compelled to revise the rates for Foreign Subscriptions, which are now as follows:—

	3 months.	6 months.	12 months
For Foreign Parts and Colonies:—	s. d.	s. d.	s. d.
Within Postal Union	6 6	12 6	24 0
Aden, Borneo, Ceylon, China, India, Japan, Java, Labuan, Mozambique, New Caledonia, Persia, Philippine Islands, Siam, Transvaal, and Zanzibar	7 6	14 6	28 0
The rates for the United Kingdom remain as follows:—	5 0	10 0	19 6

TO ADVERTISERS.

"The Electrician" *offers exceptional advantages to Advertisers.* **It has the largest circulation of any English Electrical paper, and circulates all over the World.**

Particulars relating to Advertisements will be promptly forwarded on application to the office.

Trade Advertisements *intended for the current issue must be handed in not later than First Post on Thursday morning.*

Small Prepaid Advertisements *(for Rates see page xiii.) are accepted up to 4:30 p.m. on Thursday.*

TECHNICAL PRINTING.

"The Electrician" Printing and Publishing Company (Limited) *beg to inform Electricians, Electric Light Engineers, &c., that they make a specialty of Technical Printing, and have a Staff thoroughly acquainted with Electro-Technology. They can, therefore, promise Accuracy and Despatch in the Printing of Electrical Catalogues and Electro-Technical Literature generally.*

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.

Royal 8vo.

Early in each year is issued "The Electrician" Electrical Trades' Directory and Handbook. *The Directory was established in 1883, and the 1889 Edition consisted of more than 600 pages of printed matter. The names and addresses of all persons engaged in the Electrical Industries may be relied upon as accurate. Useful Tables and Electrical Formulæ, and information specially compiled for this work are given, together with popularly-written Biographical Notices of the leading Electricians, Electrical Engineers, &c., accompanied in many cases by Portraits.*

The issue for 1890, which will be still further enlarged and improved, is in active preparation, and will shortly be ready. Orders should be forwarded at once to the Publishing Office, **1,** *Salisbury-court, Fleet-street, London, E.C.*

CONTENTS OF THE CURRENT NUMBER.

Notes 259
Magnetism in Iron and other Metals.—III. By Prof. J. A. Ewing, F.R.S. Illustrated. Continued 259
Underground Mains. By G. L. Addenbrooke 260
The Mather and Platt Alternator. Illustrated 262
Transformers. By Harris J. Ryan. Illus. Concluded ... 263
Meetings of Scientific Societies. 265
Advances of Magnetism 266
Reviews 267
The Institution of Electrical Engineers 268
The Institution of Electrical Engineers—
Dr. John Hopkinson's Presidential Address.—Magnetism. Illus. Continued 269
An Improved Standard Clark Cell with Low Temperature-Coefficient. By H. S. Carhart 271
American Notes 272
Paris Notes 274
Correspondence—
The "Economic Ratio" of a Traction System.—H. J. S. Heather 274
An Alternate-Current "Transmuter."—R. Langton Cole 274
William Sturgeon.—Silvanus P. Thompson 274
Draft Board of Trade Electric Light Regulations 275
Trade Notes and Notices 276
Books Received 277
The Stocher-Sedlaczek Arc Lamp. Illustrated 277
Companies' Meetings, &c.—
Eastern Telegraph Company (Limited) 277
The Direct United States Cable Company (Limited).. 279
New Companies Registered ... 279
City Notes, &c. 279
Companies' Share List 280

"THE ELECTROTECHNISCHE-ZEITSCHRIFT" OF BERLIN.

In future the above journal (with which has been incorporated "The Centralblatt für Electrotechnik") will be issued weekly instead of fortnightly, the subscription being **£1. 4s. 6d.** *per annum. Single Copies* **6d.; post free, 7½d.**

"THE ELECTRICAL WORLD" OF NEW YORK.

"The Electrical World" of New York *can be obtained from* "The Electrician" *Office, Salisbury-court, Fleet-street, London, E.C. The Rate of Subscription (payable in advance), is* **£1 1s.** *per annum. Single Copies* **price 6d. each; post free, 8d.**

"The Electrician" Printing and Publishing Company, Ltd., *are Agents in Great Britain for both the above well-known journals, and particulars as to Advertisements will be supplied on application to "The Publisher," 1, Salisbury Court, Fleet Street, E.C.*

ADVANCES IN MAGNETISM.

Few of those who are outside the ranks of the technical electricians know or realise the vast advance which has been made in the last ten years in our knowledge of magnetism, and in particular of the magnetic properties of iron, steel, and nickel. The average student of physics who attends lectures by the average professor of physics, or who reads only the average text-book of physics—dating probably, on an average, ten years behind the time—is at a cruel disadvantage compared with the man who has devoted attention to the construction of dynamos or the action of transformers; for it is in the development of these practical appliances of electricity that the necessity for learning more about the magnetic qualities of materials has arisen. There is an old-fashioned science of electricity which dealt with electric fluids and action at a distance, with intensity currents and frictional machines; and a modern science of electricity which deals with potentials and resistances, with dynamos and voltmeters, with coefficients of self-induction, accumulators, and transformers. The former is the science of the schools and of the Science and Art Department; the latter is the science of the electrical engineer. So also there are two sciences of magnetism. There is the old science dealing with free magnetism and surface distribution of magnetic fluids, with magnetic moments, with torsion balances, with methods of single touch, and methods of double touch, and a hundred other relics of antiquity. And there is the new science of magnetism, which deals with permeability, hysteresis, magnetic circuits, integral magnetising forces, critical temperatures,

Digitized by Google

coefficients of leakage, and the like: in fact, with all those things which are of importance to the electrical engineer. The transition from the older to the newer science of magnetism, which has come about in so few years, may be yet far from complete; nevertheless, it makes an enormous stride forward in the handling of magnetic topics. This great advance, one portion of which formed the theme of the Presidential Address to the Institution of Electrical Engineers, has come about partly from the recognition of the principle of the magnetic circuit, partly as the result of the extended and careful experimental researches on magnetism which have been carried out in recent years. In these researches a prominent place must be assigned to the PRESIDENT himself for his careful determinations of the magnetic qualities of different brands of iron and steel; and his quite recent researches on the magnetic properties of the manganiferous and nickeliferous alloys of iron are rapidly becoming classical.

Fifty years ago the principle of the magnetic circuit very dimly suggested itself to the minds of two or three—to CUMMING, to RITCHIE, and to STURGEON; and but a few years later it assumed a more definite form in the hands of our lately deceased philosopher JOULE, who enunciated its main points. According to JOULE the induction in a magnetic circuit was proportional to its least sectional area, and the resistance to induction was proportional to the length of the magnetic circuit. To Sir WILLIAM THOMSON we owe the happy term *permeability* to denote the idea of magnetic conductivity of the material through which the magnetic lines pass. Prof. ROWLAND seems to have been the first, now nearly seventeen years ago, to point out that the law of the magnetic circuit could be expressed in exact terms similarly to the law of OHM, the number of magnetic lines flowing along the circuit being calculated from the "magnetising force of the helix" and the "resistance to lines of force" of the iron. In 1882 and 1883 a similar line was pursued by Mr. BOSANQUET in a series of magnetic researches of very great value, which somehow seem never to have received the recognition which they so thoroughly deserve, being models of careful and patient work. The more recent Paper by the PRESIDENT of the INSTITUTION of ELECTRICAL ENGINEERS in conjunction with his brother, Dr. EDWARD HOPKINSON, and that by Mr. KAPP, both dealing with the magnetic circuits of dynamo machines, are within the memory of every electrical engineer. The ten-year-long researches of Prof. EWING, though they do not directly deal with the topic of the magnetic circuit, have furnished a mass of statistical information about the properties of iron, steel, and nickel; and are, indeed, of primary importance. Prof. EWING'S work on hysteresis alone is enough to hand down his fame. Nor in this connection ought one to forget how the method of examining the magnetic properties of materials made up in the form of rings, originated by STOLETOW, has been pursued by ROWLAND, BOSANQUET, HOPKINSON, and others; nor how BIDWELL has employed the method of traction between two halves of a divided ring to measure its magnetic permeability. Prof. HUGHES has examined the influence on magnetism of torsion; WIEDEMANN has given a large number of numerical data, and a theory of the molecular actions which occur in the torsion of iron and steel under magnetisation. Sir WILLIAM THOMSON discovered the effect of stress upon the magnetic permeability of iron, and connected the observation of JOULE on the longitudinal expansion of iron during magnetisation with the diminution of its magnetisability when subjected to a longitudinal compression from without. Prof. BARRETT has observed the converse behaviour of nickel, and Mr. SHELFORD BIDWELL has pursued the matter with still higher magnetising forces, and found iron so treated to contract. Prof. EWING has made a special study of the variations of magnetic qualities of materials under varied circumstances of stress, and has greatly enriched our store of exact observations.

Dr. HOPKINSON'S address will, doubtless, stimulate an increased interest in magnetic researches: the more so as he has thrown himself into the modern modes of thought, and deliberately cut himself off from the antique notions which cling around the phrases magnetic moment, superficial density of magnetisation, and the like. The very cases chosen for discussion by Dr. HOPKINSON preclude a return to the older modes of thought. He presents to our consideration a symmetrical iron ring, overwound with a magnetising coil, and with a secondary coil for the purpose of exploring its magnetisation. With such an apparatus the magnetisation is purely internal, following a closed circuit through the substance of the ring core. Poles it has none; free surface magnetisation none; susceptibility of end surfaces to receive magnetism none; magnetic moment none. One is naturally *compelled* to regard it as constituting a magnetic circuit; to think of the magnetising force acting around it; of the resistance to magnetisation offered by the iron; of the actual resulting flow of magnetic lines through the iron core as proportional directly to the former and inversely to the latter. One falls simply and naturally into the law of the magnetic circuit: that law which, similar in all mathematical points to the great law of OHM for electric circuits, is gradually winning its way into acceptance. OHM'S law unlocked many mysteries to the electrician: the law of the magnetic circuit is similarly destined to unravel the many complications and apparent contradictions at present encumbering the science of magnetism. For the sake of the practical men, already familiar with the law of OHM, it is a pity that Dr. HOPKINSON has not frankly used the term magnetic resistance of the circuit, but has left it in its reciprocal form as conducting power. Of course, an accomplished mathematician like Dr. HOPKINSON can think things out in the reciprocals of their values with perfect readiness. Less highly-trained minds need to have new notions presented to them in more readily assimilable forms, and Dr. HOPKINSON is the last man in the world to prefer to express himself less intelligibly than he might have done. As resistance is the mere mathematical inverse of conductance, dividing by a resistance comes to identically the same thing as multiplying by a conductance. Dr. HOPKINSON does the latter, whilst the practical man is accustomed to do the former. When ten years hence, in the year 1900, the then PRESIDENT of the INSTITUTION of ELECTRICAL ENGINEERS shall come to write his Presidential Address he will be lost in wonder how it was that so late as 1890 the simple law of the magnetic-circuit—OHM'S law for magnetism—was a novelty little known and less used, too novel to be frankly accepted in a Presidential Address dealing with the magnetic properties of matter.

REVIEWS.

A Dictionary of Electrical Words, Terms, and Phrases. By E. J. HOUSTON. (The W. J. Johnston Company, New York, and "THE ELECTRICIAN" Printing and Publishing Company, London. 1889.)

This is a volume of about 650 pages, consisting of a series of short, explanatory articles on almost every electrical subject, and on many more or less closely allied ones. The articles are replete with useful information, and concisely expressed, and the errors are, on the whole, comparatively few. One of the most important of these is the definition of the C.-G.-S. unit of current given under the heading "Ampère." The unit current should be defined as a current such that if passed through a conducting wire bent into a circle of a radius of one centimetre,

Digitized by Google

each centimetre of the conductor would attract a unit magnetic pole at its centre with a force of a dyne. The definition, as given by Mr. Houston, would make the unit current $\frac{1}{2\pi}$ of its actual value. Another slip which occurs in this paragraph is the statement that an ampere per second is equal to a coulomb. There is no meaning in the expression "ampere per second," and the statement should be—an ampere is equal to a coulomb per second. Some of the definitions, as, for example, that of magnetic permeability, are extremely vague, when it would be just as easy to give exact numerical ones. The definition given of the coefficient of magnetisation is not correct, nor is that of the coefficient of self-induction, which the author confounds with the total self-induction of a circuit. In the light of recent researches a little more space might be devoted to the subject of electrical oscillations, which, moreover, can hardly be correctly described as consisting of partial intermittent discharges. The omission of all mention of the pentane standard lamp ought to be rectified in a second edition.

The work is one which will be of considerable value both to practical electricians and to students, as it contains in a condensed form a mass of information upon a great number of electrical terms and subjects, and much of this is not always readily accessible when required. If we have appeared to give prominence to the more important of the few errors and omissions which we have noticed it is because we consider the work of sufficient value and importance to make it desirable that the defects which appear in the first edition should be remedied in the succeeding ones. G. W. DE T.

Practical Electrical Notes and Definitions. By W. PERREN MAYCOCK. (London: E. and F. N. Spon.)

This is a compact little pocket-book, containing well-arranged and well-expressed information on the main points connected with the chief commercial applications of electricity. It is a book that will doubtless prove useful to that now large section of the public who find it essential to acquire a correct knowledge of the meaning of those electrical terms which are in common use. The author has for the most part confined himself with praiseworthy strictness to notes and definitions. The following paragraphs, in the prophetic vein cannot, however, be included under the heading either of notes or definitions, and might, therefore, with advantage be modified or eliminated in the next edition:—"152. The electric transmission of power is destined to become of far greater importance than all these combined. 153. Our present greatest source of energy, coal, has nowadays to be distributed broadcast over the face of the country at considerable expense before its energy can be utilised. At some future period, probably not far distant, it will be burnt at the pit's mouth, and its power electrically distributed with infinitely less loss and expense than now. 154. But this is as nothing. The time will come when the immense tidal energy all over the world will be made to do useful work, and, by the medium of electricity, furnish man with all he can require—power, heat, and light."

Examples of Lathes, Apparatus, and Work. By the Author of "Lathes and Turning." (London: E. and F. N. Spon.)

This little pamphlet of 48 pages gives much useful information with regard to the newer forms of lathe tools, more especially those required in ornamental turning. There are no fewer than 61 illustrations, of which 30 are devoted to the tools and lathes described, and the remainder illustrate specimens of the work executed by the special tools. On p. 23 we have an illustration of the "Geometric," which is a somewhat novel form of screw-cutting lathe. The term "geometric" is applied to the lathe in consequence of all its sliding movements being furnished with measuring arrangements, by which devices it is claimed that definite dimensions may be obtained with ease and certainty without the continual use of gauges and callipers. These definite movements are said to be made by making all the traversing screws of aliquot pitches of convenient numbers, and fitting the screws with small division plates. Owing to the special construction of the leading screw of this lathe, it is claimed that the compound slide-rest can be dispensed with for every kind of work, except some sorts of angular work; and the lathe is so arranged that it can be removed altogether when not in use, thus giving a clear bench. Though most of the apparatus described is more especially useful to those engaged in geometric and ornamental turning, still there are many appliances of general interest.

Magnetism and Electricity. Advanced and Honours Questions. By ANDREW JAMIESON, M.I.C.E. (London: Charles Griffin & Co.)

This is a little pamphlet of some 24 pages compiled specially for the use of those who are preparing for examinations in these subjects. The pamphlet contains all the advanced and honours theoretical questions set at the Science and Art Department's May examinations during the last eight years, as well as all the honours practical testing questions since their first institution in 1886, all the questions leading to numerical results being followed by the answers. There is no better preparation for anyone who is about to undergo the ordeal of an examination than to familiarise himself with the style of question which is in vogue by running through Papers previously set. It is needless to say that we do not suggest that this course of reading should form the chief educational pabulum of examinees, and we recommend it merely as a final dose to be taken immediately before examination.

Ordinary and Honours Questions on Electrical Engineering. By ANDREW JAMIESON, M.I.C.E. (London: Charles Griffin and Co.)

This pamphlet is similar in size and scope to that reviewed above. It contains all the ordinary and honours questions set at the City and Guilds Technological Examinations in electric lighting and transmission of power, telegraphy, and telephony, since these examinations were first instituted, as well as others by Prof. Jamieson himself.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

The first meeting of the new session of the Institution of Electrical Engineers was held at the Institution of Civil Engineers on Thursday last week, Sir William Thomson, the retiring President, occupying the chair. We are indebted to *The Times* for the following report of the proceedings which took place previous to the delivery of Dr. Hopkinson's inaugural address, the continuation of which will be found in another column.

Sir WILLIAM THOMSON, before formally vacating the President's chair, delivered a short address. He pointed out that the Institution of Electrical Engineers was not, in its origin, merely a Society for electric lighting and the electric transmission of power. The great developments of recent years tended to concentrate attention on electric lighting; but it ought to be remembered that electrical engineering had originated in submarine cable enterprise. Before this electric telegraphy had hardly a better claim to be regarded as engineering than had bell-hanging. The founders of the Society were telegraphists and the great majority of them were submarine telegraphists; and all must rejoice to see that they possessed a new Member of the Council in Sir James Anderson, who had been so largely associated with cable work. It was not, perhaps, generally remembered that before the cable of 1865 a cable was laid in 1858, and in the company that laid it he and Sir John Pender were directors. Before the failure of the cable some important public messages were transmitted, notably one to countermand an order for two regiments to go from Canada to India to aid in the suppression of the mutiny. After the failure of that cable, but for the persistent, strenuous, and self-sacrificing determination of such men as Sir John (then Mr.) Pender and Mr. Cyrus Field the enterprise would have died. When, in 1865, the "Great Eastern" returned to England, having failed to pick up the broken cable, great discouragement was felt, and if Sir John Pender had not come forward to guarantee a quarter of a million of the funds required, many more years must have elapsed before the successful laying of an Atlantic cable was finally accomplished. The Institution of Electrical Engineers had a double duty—it had a duty to science and a duty to those who paid for the work. Therefore it was proper to consider how much money had been expended in various forms of electrical enterprise. In Europe, the Americas, Egypt, South Africa, Japan, India, &c., no less than 1,714,000 English miles of land telegraphs had been constructed, and the estimated value of these was £51,728,500. Of cables, 107,547 miles had been laid down by com-

Digitized by Google

panies, at a capital outlay of £36,000,000. By Government 12,523 miles of submarine cable had been laid, at a cost of £3,700,000. The figures connected with electric lighting were not so large, but were destined to be much larger. In this direction three or four millions had been spent or subscribed.

Mr. W. H. PREECE, F.R.S., then proposed, and Prof. AYRTON seconded, a vote of thanks to Sir William Thomson for his services during his year of office, and, the vote having been agreed to by acclamation, Dr. J. Hopkinson, F.R.S., the President for the new year, was installed in the chair.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

DR. JOHN HOPKINSON'S PRESIDENTIAL ADDRESS.

Magnetism.

(Continued from page 247.)

I have already called emphatic attention to the fact that magnetic substances are enormously magnetic, and that non-magnetic substances are hardly at all magnetic; there is between the two classes no intermediate class. The magnetic property of iron is exceedingly easily destroyed. If iron be alloyed with 12 per cent. of manganese, the kick on the galvanometer which the material will give, if made into a ring, is only about 25 per cent. greater than is the case with the most completely non-magnetic material, instead of being some hundreds of times as great, as would be the case with iron. Further, with this manganese steel the kick on the galvanometer is strictly proportional to the magnetising current in the primary, and the material shows no signs of hysterisis. In short, all its properties would be fully accounted for if we supposed that manganese steel consisted of a perfectly non-magnetic material, with a small percentage of metallic iron mechanically admixed therewith. Thus the property of non-magnetisability of manganese steel is an excellent proof of the fact—which is also shown by the non-magnetic properties of most compounds of iron—that the property appertains to the molecule, and not to the atom; or, to put it in another way, suppose that we were to imagine manganese steel broken up into small particles, as these particles became smaller there would at length arrive a point at which the iron and the manganese would be entirely separated from each other; when this point is reached the particles of iron are non-magnetic. By the magnetic molecule of the substance we mean the smallest part which has all the magnetic properties of the mass. The magnetic molecule must be big enough to contain its proportion of manganese. In iron, then, we must have a collection of particles of such magnitude that it would be possible for manganese to enter into each of them, to constitute an element of the magnet. Manganese is, so far as I know, a non-magnetic element. Smaller proportions of manganese reduce the magnetic property in a somewhat less degree, the reduction being greater as the quantity of manganese is greater. It appeared very possible that the non-magnetic property of manganese steel was due to the coercive force being very great—that, in fact, in all experiments we were still on that part of the magnetisation curve below the rapid rise, and that if the steel were submitted to greater forces it would presently prove to be magnetic, like other kinds of steel. Prof. Ewing, however, has submitted manganese steel to very great forces indeed, and finds that its magnetism is always proportional to the magnetising force.

No single body is known having the property of capacity for magnetism in a degree which is neither very great nor very small, but intermediate between the two extremes. We can, however, mix magnetic and non-magnetic substances to form bodies apparently intermediate. It is, therefore, interesting to consider what the properties might be of such a mixture. It depends quite as much on the way in which the magnetic part is arranged in the mass, as on its actual quantity. Suppose, for example, it is arranged in threads or plates having a very long axis in the direction of the magnetising force, we may at once determine the curve of magnetisation of the mixture from that of the magnetic substance by dividing the induction for any given force in the ratio of the whole volume to the volume of magnetic substance. If, on the other hand, it is arranged with a very short axis in the direction of the force, and a long axis perpendicular thereto, we can equally construct the curve of magnetisation. This is done in Fig. 4, which shows the curve when nine-tenths of the material is highly magnetic iron arranged in the latter way, whilst the other curve of the same figure is that when one one-tenth is magnetic, but arranged in the former way. You observe how very different is the character of the curve—a difference which is reduced by the much less proportion of magnetic material in the mixture in the one case than in the other. One peculiarity of these arrangements of the two materials in relation to each other is, that the resulting material is not isotropic; that is, its properties are not the same in all directions, but depend upon the direction of the magnetising force in the material.

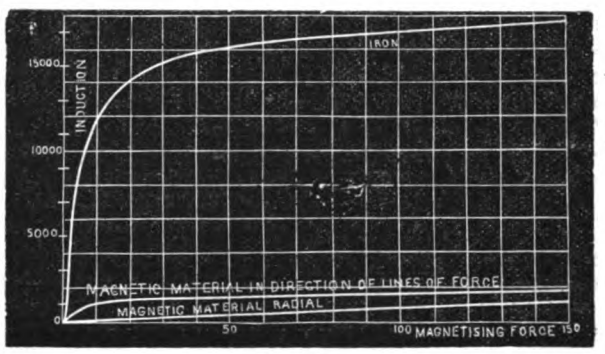


FIG. 4.

Of course, this is not at all a probable arrangement, but it is instructive in showing the character of the result as depending upon the construction of the material. Let us, however, consider the simplest isotropic arrangement; let us suppose that one material is in the form of spheres bedded in a matrix of the other: if the spheres are placed at random this is clearly an isotropic arrangement. The result is very different according as the matrix or the spheres are of the magnetic material. Suppose that the volume of the spheres is one-half of the whole volume. In Fig. 5 we have approximately the curve for iron, for a mixture of equal quantities of iron and a non-magnetic material; the spheres being non-magnetic and the matrix iron, and for a mixture, the spheres being iron, and the matrix non-magnetic. Observe the great difference. When the spheres are iron, the induction is near four times the force for all values of the force. When the matrix is iron, the induction is near $\frac{2}{3}$ths of the induction when the material is iron only.

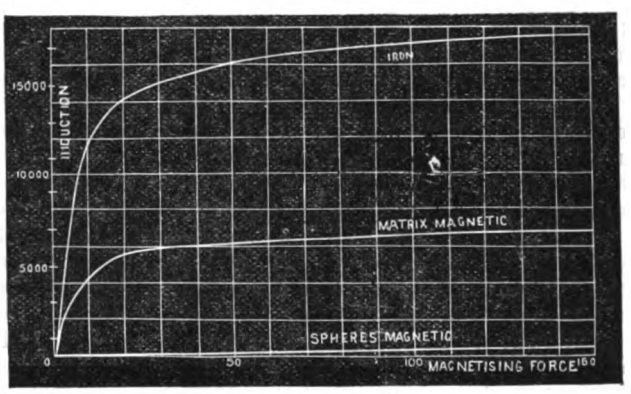


FIG. 5.

In speaking oi the properties of bodies which, like manganese steel, are slightly magnetic, it may be well here to enter a caution. But little that is instructive is to be learned by testing filings, or the like, with magnets, as these show but little difference between bodies which are slightly magnetic and those which are strongly magnetic. Suppose the filings to be spheres, in the following table are given comparative values of the forces they would experience in terms of μ, if placed in a magnetic field of given value, μ having its ordinary signification—that is, being the ratio of the kick on the galvanometer when a

Digitized by Google

ring is tried made of the material of the filing to the kick if the ring is made of a perfectly non-magnetic material :—

μ.	Attraction.	——
1	0	Non-magnetic body.
1·47	0·18	Manganese steel with 12 per cent.
3·6	1·2	Manganese steel with 9 per cent.
5	1·5	
10	2·1	
100	2·8	
1000	2·98	

Now bodies in which μ is so small as 3·6 belong distinctly to the non-magnetic class ; but the test with the magnet would very markedly distinguish them from manganese steel with 12 per cent. of manganese. The distinction, however, between $\mu = 3{\cdot}6$ and $\mu = 1{,}000$ is comparatively small ; whereas, under the conditions of experiment, μ is much more than 1,000 for most bodies of which iron is the principal constituent.

The effect of stress on the magnetic properties of iron and nickel have been studied by Sir W. Thomson. A fact interesting from a broad and general point of view is that the effects of stress are different in kind in the case of iron and nickel. In the case of iron, for small magnetising forces in the direction of the tension, tension increases the magnetisation ; for large forces, diminishes it. In the case of nickel the effect is always to diminish the magnetisation.

When one considers that the magnetic property is peculiar to three substances—that it is easily destroyed by the admixture of some foreign body, as manganese—one would naturally expect that its existence would depend also on the temperature of the body. This is found to be the case. It has long been known that iron remains magnetic to a red heat, and that then it somewhat suddenly ceases to be magnetic, and remains at a higher temperature non-magnetic. It has long been known that the same thing happens with cobalt, the temperature of change, however, being higher ; and with nickel, the temperature being lower. The magnetic characteristics of iron at a high temperature are interesting. Let us return to our ring, and let us suppose that the coils are insulated with a refractory material, such as asbestos paper, and that the ring is made of the best soft iron. We are now in a position to heat the ring to a high temperature, and to experiment upon it at high temperatures in exactly the same way as before. The temperature can be approximately determined by the resistance of one of the copper coils. Suppose, first, that the current in the primary circuit which we use for magnetising the ring is small ; that from time to time, as the ring is heated and the temperature rises, an experiment is made by reversing the current in the primary circuit, and observing the deflection of the galvanometer needle. At the ordinary temperature of the air the deflection is comparatively small ; as the temperature increases the deflection also increases, but slowly at first, when the temperature, however, reaches something like 600°C., the galvanometer deflection begins very rapidly to increase, until, with a temperature of 770°C., it attains a value of no less than 11,000 times as great as the deflection would be if the ring had been made of glass or copper, and the same exciting current had been used. Of course a direct comparison of 11,000 to 1 cannot be made : to make it we must introduce resistance into the secondary circuit when the iron is used ; and we must, in fact, make use of larger currents when copper is used. However the ratio of the induction in the case of iron to that in the case of copper, at 770°C., for small forces is no less than 11,000 to 1. Now mark what happens. The temperature rises another 15°C. ; the deflection of the needle suddenly drops to a value which we must regard as infinitesimal in comparison to that which it had at a temperature of 770°C. ; in fact, at the higher temperature of 785°C. the deflection of the galvanometer with iron is to that with copper in a ratio not exceeding that of 1·14 to 1. Here, then, we have a most remarkable fact : at a temperature of 770°C. the magnetisation of iron 11,000 times as great as that of a non-magnetic substance ; at a temperature of 785°C. iron practically non-magnetic. These changes are shown in Fig. 6. Suppose, now, that the current in the primary circuit which serves to magnetise the iron had been great instead of very small. In this case we find a very different order of phenomena. As the temperature rises the deflection on the galvanometer diminishes very slowly till a high temperature is attained ; then the rate of decrease is accelerated until, as the temperature at which

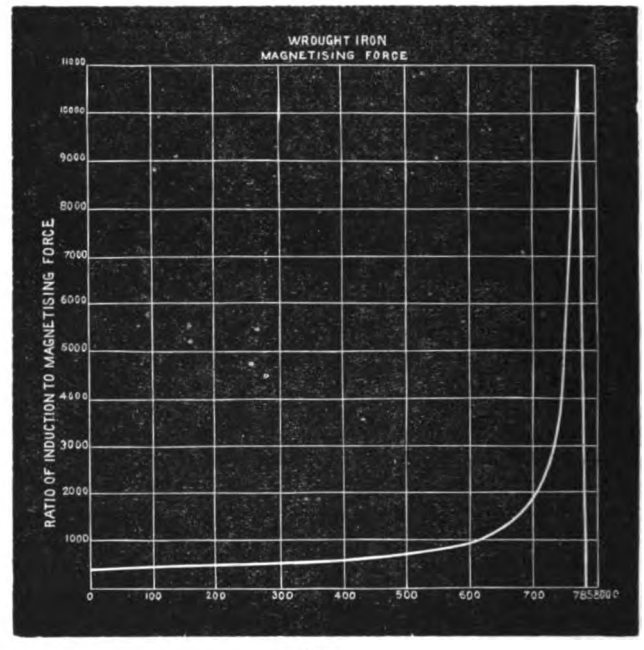


Fig. 6.

the sudden change occurred for small forces is reached, the rate of diminution becomes very rapid indeed, until, finally, the magnetism of the iron disappears at the same time as for small forces. Instead of following the magnetisation with constant

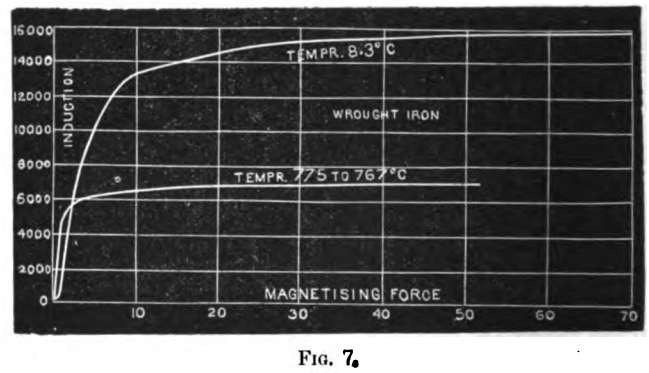


Fig. 7.

forces for varying temperatures, we may trace the curve of magnetisation for varying forces with any temperature we please. Such curves are given in Diagrams 7 and 8. In the one diagram, for the purpose of bringing out diffe-

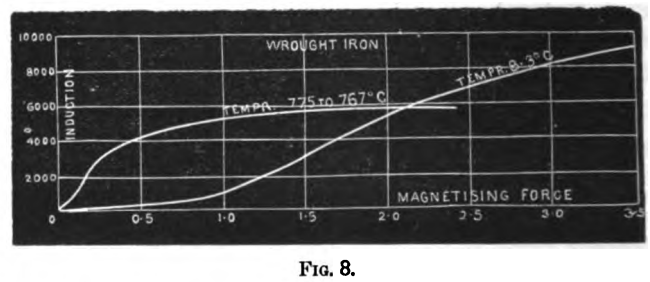


Fig. 8.

rent points in the curve, the scale of abscissæ is twenty times as great as in the other. You will observe that the effect of rise of temperature is to diminish the maximum magnetisation of which the body is capable, slowly at first, and rapidly at the end. It is also very greatly to diminish the

Digitized by Google

coercive force, and to increase the facility with which the body is magnetised. To give an idea of the magnetising forces in question, the force of Fig. 6 was 0·3; and as you see from Figs. 7 and 8, the force ranges as high as 60. Now the earth's force in these latitudes is 0·43, and the horizontal component of the earth's force is 0·18. In the field of a dynamo machine the force is often more than 7,000. In additional to the general characteristics of the curve of magnetisation, a very interesting and, as I take it, a very important fact comes out. I have already stated that if the ring be submitted to a great current in one direction, which current is afterwards gradually reduced to zero, the ring is not in its non-magnetic condition, but that it is, in fact, strongly magnetised. Suppose, now, we heat the ring, whilst under the influence of a strong magnetising current, beyond the critical temperature at which it ceases to have any magnetic properties, and that then we reduce the current to zero,

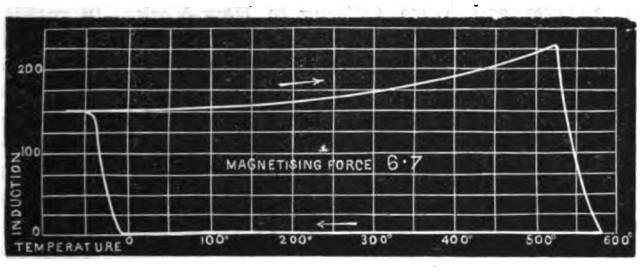


Fig. 9.

we may in this state try any experiment we please. Reversing the current on the ring, we shall find that it is in all cases non-magnetic. Suppose next that we allow the ring to cool without any current in the primary, when cold we find that the ring is magnetised; in fact, it has a distinct recollection of what had been done to it before it was heated to the temperature at which it ceased to be magnetic. When steel is tried in the same way with varying temperatures, a similar sequence of phenomena is observed; but for small forces the permeability rises to a lower maximum, and its rise is less rapid. The critical temperature at which magnetism disappears changes rapidly with the composition of the steel. For very soft charcoal iron wire the critical temperature is as high as 880° C; for hard Whitworth steel it is 690° C.

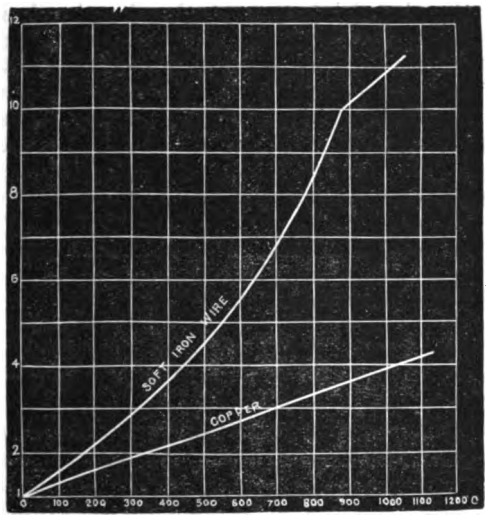


Fig. 10.

The properties of an alloy of manganese and iron are curious. More curious are those of an alloy of nickel and iron. The alloy of nickel and iron containing 25 per cent. of nickel is non-magnetic as it is sure to come from the manufacturer—that is to say, a substance compounded of two magnetic bodies is non-magnetic. Cool it, however, a little below freezing, and its properties change; it becomes very decidedly magnetic. This is perhaps not so very remarkable: the nickel steel has a low critical temperature—lower than we have observed in any other magnetisable body. But if now the cooled material be allowed to return to the ordinary temperature it is magnetic; if it be heated it is still magnetic, and remains magnetic till a temperature of 580°C is attained, when it very rapidly becomes non-magnetic, exactly as other magnetic bodies do when they pass their critical temperature. Now cool the alloy: it is non-magnetic, and remains non-magnetic till the temperature has fallen to below freezing. The history of the material is shown in Fig. 9, from which it will be seen that from – 20° C to 580° C this alloy may exist in either of two states, both quite stable—a magnetic and a non-magnetic—and that the state is determined by whether the alloy has been last cooled to – 20° C or heated to 580° C.

Sudden changes occur in other properties of iron at this very critical temperature at which its magnetism disappears. For example, take its electrical resistance. On the curve, Fig. 10, is shown the electrical resistance of iron at various temperatures, and also the electrical resistance of copper or other pure metal. Observe the difference. If the iron is heated, its resistance increases with an accelerating velocity, until, when near the critical temperature, the rate of increase is five times as much as the copper; at the critical temperature the rate suddenly changes, and it assumes a value which, as far as experiments have gone, cannot be said to differ very materially from a pure metal. The resistance of manganese steel shows no such change; its temperature coefficient constantly has the value of ·0012, which it has at the ordinary temperature of the air. The electrical resistance of nickel varies with temperature in an exactly similar manner. Again, Prof. Tait has shown that the thermo-electric properties of iron are very anomalous—that there is a sudden change at or about the temperature at which the metal becomes non-magnetic, and that before this temperature is reached the variations of thermo-electric property are quite different from a non-maguetic metal.

(*To be continued.*)

AN IMPROVED STANDARD CLARK CELL WITH LOW TEMPERATURE-COEFFICIENT.*

BY H. S. CARHART.

The best form of Clark cell hitherto made is that of Lord Rayleigh, described in the *Philosophical Transactions* for 1885. The objections to this form are that the temperature-coefficient is not the same for all cells, as is shown in Lord Rayleigh's Paper, and it is so high as to introduce a very troublesome and uncertain error, because of the difficulty of ascertaining the exact temperature of the cell; secondly, it is not so constructed mechanically as to prevent the mercury from coming into contact with the zinc when the cell is subjected to violent jars in transportation; thirdly, a great chemical defect is the facility with which local action takes place between the zinc and the mercury salt. I might add that the mercurous sulphate purchased by Lord Rayleigh evidently contained considerable salt in the mercuric form, as is shown by its turning yellow on mixing with the zinc-sulphate solution.

All these difficulties I have, at least in large measure, overcome. Respecting the materials, the greatest care is required to secure and maintain cleanliness and purity in their preparation. The mercury must be distilled *in vacuo* after being cleaned by chemical means. The zinc sulphate should be free from iron as well as other impurities. The mercurous sulphate can be made almost or quite free from the mercuric form by using plenty of mercury, keeping the temperature down to the lowest point at which action will take place, and letting the mixture of salt, acid, and metallic mercury stand for some time. I have made in this way a salt that remains white, not only when the free acid is all washed out, but when mixed with the standard zinc-sulphate solution. Further, it remains white in the cell indefinitely if it is not exposed to a bright light.

Hitherto the importance of the local action going on in a Clark cell appears not to have been appreciated. It accounts for some of the differences in temperature-coefficient, and leads to some more serious results in some cells. The zinc replaces mercury when in contact with the mercury salt. This amalgamates the zinc, producing a slight change in the E.M.F.; and then the amalgam is liable to creep up to the top of the zinc, where it attacks the solder. The copper wire is thus sometimes loosened. The zinc sulphate follows up, and the cell may be thus short-circuited by the zinc

* From the *Phil. Mag.*

Digitized by Google

and the copper wire. Upon taking down one cell, which was perhaps a year old, I found that the zinc had been removed from the rod at the surface of the liquid, and had been deposited again upon the rod at the surface of the mercury salt, in a solid frill round the zinc. The copper wire in this cell became entirely detached, partly because of the expansion upward of the marine glue, which brought a severe strain upon the wire.

The local action then increases the zinc sulphate in the cell at the expense of the mercury sulphate and amalgamates the zinc rod. I have become convinced by some experiments extending over several weeks that this substitution process goes on only when the zinc is in contact with the solid mercury salt. The mercurous sulphate is only slightly soluble in a saturated solution of zinc sulphate. I therefore prevent local action by keeping the zinc and the mercury salt out of contact. The same device operates to raise the E.M.F. about 0·4 per cent. The following table exhibits the observed and calculated values of the E.M.F. of cells No. 17, 112, 113 in terms of No. 1 (old style) at 20°C. :—

No. 17.			No. 112.		
Temp. C.	Observed.	Calculated.	Temp. C.	Observed.	Calculated.
Deg.			Deg.		
8·3	1·0108	1·0106	5·1	1·0124	1·0125
8·5	1·0103	1·0105	10·6	1·0106	1·0103
9·3	1·0104	1·0102	12·5	1·0098	1·0096
11·8	1·0093	1·0092	15·2	1·0087	1·0086
13·8	1·0084	1·0085	19·5	1·0069	1·0069
15·0	1·0080	1·0080	21·2	1·0062	1·0062
18·1	1·0069	1·0068	31·1	1·0024	1·0024
19·4	1·0064	1·0063			
19·9	1·0062	1·0061			
20·3	1·0060	1·0059			
20·8	1·0054	1·0057			
21·1	1·0057	1·0056			
21·6	1·0054	1·0055	No. 113.		
22·4	1·0050	1·0052			
23·3	1·0048	1·0048	5·1	1·0124	1·0125
25·1	1·0044	1·0041	10·6	1·0106	1·0104
26·4	1·0035	1·0036	12·5	1·0098	1·0097
30·2	1·0019	1·0022	15·2	1·0088	1·0087
33·1	1·0014	1·0013	19·5	1·0070	1·0070
39·1	0·9991	0·9989	21·2	1·0062	1·0063
41·7	0·9980	0·9979	31·1	1·0025	1·0025
50·4	0·9949	0·9947			
52·7	0·9939	0·9940			

Cell No. 1 was always very near 20° C., and the reduction to that temperature was made by means of Lord Rayleigh's reduction-co-efficient, ·00077 per degree C.

The equation for the E.M.F., derived from the observations on No. 17, is

$$E' = E[1 - ·000387(t-15) + ·0000005(t-15)^2].$$

The calculated values for the three cells were all obtained by this formula. The change for 1°C. is, then, the following linear function of the temperature :—

$$-·000386 + ·000001(t-15).$$

The temperature-coefficient ranges from ·000361 at 0°C. to ·000376 at 25°C., and to ·000361 at 40°C. At the highest observed temperature in the preceding table it was only ·000348. The curve of E.M.F. with temperatures as abscissæ is clearly concave upward, indicating a fall in the temperature-coefficient with rise of temperature. The change is, however, so small as to be quite negligible within the range of temperature to which a normal element is subjected in practice. Lord Rayleigh's cells show a change in the temperature-coefficient directly the reverse of the above ; that is, the coefficient increases by a very appreciable quantity with rise of temperature. For his No. [36] the coefficient ranged from ·000556 at 0°C. to ·00101 at 25°C., if his equation holds true for the higher temperature.

In making comparisons of E.M.F. I have used Lord Rayleigh's method, slightly modified, by means of which a difference of one ten-thousandth part is observed directly and with the greatest ease. In fact, a difference of half that amount is easily measured. A comparison of half-a-dozen cells can be made in as many minutes without difficulty.

As to polarisation, these cells show none with external resistance greater than 30,000 ohms. At 30,000 ohms the polarisation is just discernible ; and with 10,000 ohms it amounts to only one ten-thousandth part in five minutes. This fall in E.M.F. is less than the accidental differences between different cells in general, and much smaller than the almost unavoidable errors due to ignorance of the real temperature of the cell. If the cell is not closed on less than 10,000 ohms resistance, and only for a few minutes, the polarisation may be entirely neglected.

As indicating the uniformity attained, the following relative values of the E.M.F. of six cells, only four days old, may be given :—9048, 9049, 9049, 9048, 9046, 9043. The last one was still approaching the others when last observed. Six cells of later construction gave the following relative values when less than two days old :—9182, 9182, 9182·5, 9182, 9182, 9182·5. The two sets of numbers do not represent at all the relative values of one set as compared with the other.

It will be seen from the table that Nos. 112 and 113 never differ by more than one part in ten thousand at the same temperature.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *January* 4, 1890.

The Overhead Wire Cutting in New York.—In my last letter I was able to refer to the marked change in tone on the part of the press here with regard to the question of electricity and its dangers. Now, however, that the wires in most of the streets are down, and that the thoroughfares are dark, the papers have so changed their tone that it seems hardly possible they could blow hot and cold in so short a space of time. One of the things which has brought them to their senses has undoubtedly been the outcry from the merchants and manufacturers in all parts of the city as to the damage that has been done to their business by this reckless destruction of a well-established and authorised system of supply. Altogether it is probable that for light and power the local lighting companies running circuits overhead have, or had until recently at least, 2,500 to 3,000 customers, nearly every one of whom has been affected by the cutting of the wires, and I need hardly therefore go into details to inform you as to the amount of clamour that these customers are raising as to the injury inflicted upon them in their business at this season. But for the fact that a large amount of the electric lighting in New York City is done from isolated plants, I believe that the indignation on the part of the public would have been so great as to lead to an immediate removal from office of the members of the Subway Board who are responsible for the present disgraceful state of affairs. There is now a very clear understanding on the part of the intelligent citizens as to what the whole business means, and that it is largely due to political jobbery. One hopeful feature of the situation has been to advertise the fact not appreciated by the general public, that in chopping down these wires the Board of Electrical Control were not only depriving the streets of light, but were also cutting off hundreds and hundreds of business houses and factories from light and power, to which, even with crude methods of distribution, they gave a most decided preference. Of course the companies are making as much haste as possible to get into the subways, but this work takes a long time. They also have to deal with the question of putting back their wires on streets where they have been cut, but where no subways exist. In a great many cases their wires have been cut where there has been no excuse for doing so. The local companies intend to bring a suit against the city for damage inflicted on them, and it is said that their total claims amount to nearly three million dollars. There can be no doubt that the wires have been cut in the most ruthless and wanton manner. And even where the cutting was justified by the condition of the lines, it appears that the work was done before the due legal notice had been given the companies affected. Even the wires that the companies had in the subways were rendered useless by the fact that in many cases the destruction gang cut the connections between the stations and the nearest subway terminal.

The Safety of Electric Lighting.—With regard to the alleged enormous loss of life which has led to all this furore, the Board of Coroners have just made a timely return as to the number of cases sent before them last year for investigation. It appears from these figures that 21 deaths were directly attributable to gas, 80 to being run over by vehicles, 36 to falling objects, 54 to burns and scalds, and 9 to electricity. Of these nine nearly every one, as the record shows, was directly attributable to the carelessness of the workmen and linemen employed in

Digitized by Google

connection with the supply of the current, and in but two cases, as far as I am aware, was the death that of a private citizen. In view of such a showing, one wonders how it is that it has been so easy to manufacture public sentiment against electricity, and to alarm not only New York, but pretty well the whole world besides. Attention may be drawn to the fact that over in the city of Brooklyn, where they have had a commission working in harmony with the companies, and where none of the wire used is better than the ordinary underwriters' wire, there has been no injury whatever to the public, and practically none to the *employés* and the firemen. This immunity from accident is not a plea or an excuse for underwriters' wire, which we all know to be of poor and inferior insulation for outdoor purposes; but it goes to show that where the companies are not burdened with the conditions that have been imposed upon them in New York City, they can and do render efficient service, with a minimum loss of life and property.

A Westinghouse Alternating Current Arc Lamp.—For some time past there have been reports current that it was the intention of the Westinghouse Company to introduce through the companies which it controls in New York City an alternating current arc lamp, operated through wires and cables in the subways, the object being to ensure as far as possible the safety of those coming in contact with the lights on the secondary wires. Mr. George Westinghouse, jun., has just confirmed this report, and states that the company has made great progress in the perfection of such a lamp. He says that one or two machines for the supply of current have already been constructed and that these lamps will be put into service immediately. It will be interesting thus to see a revival of an old form of arc lamp with modern modifications. If I am not mistaken, the last alternating current arc lamp seen in this country was the old Jablochkoff, operated by a company which went under the control of the United States Company, and with that company became a part of the Westinghouse system. I do not think that any of the old Jablochkoff lamps are now in use, but that every one of them found its way to the scrap heap some years ago. It will be interesting to see what form this new alternating current arc lamp takes.

Electricity in Mines.—A great deal of interest is being taken at this time in the subject of electric mining, and it is thought that 1890 will see in this country as remarkable a development in the application of electric power to mining, as was seen during 1889 in the utilisation of electric power to street railways. All the electric motor companies are beginning to adapt their apparatus to special mining purposes, and some of them have already produced not a few original applications. The *Electrical World* this week devotes a considerable portion of its space to the illustration and description of American electrical mining apparatus, and gives views of at least a dozen pieces now being brought out by the Sprague Company, the electric mining locomotive of the Thomson-Houston Company, the Sperry coal cutters, and the Jeffrey cutters and locomotives. There is other apparatus newly in the field, and several inventors are known to be at work on this class of apparatus. There are in this country about five or six thousand mines in this country, and in the case of a large number, they could be worked to much better advantage with the aid of electrical appliances, especially where water power happens to be within half-a-dozen miles. In the western mining country several applications of electricity have already been made with satisfactory results, and the mining world is well alive to the advantages offered by the new power. A large number of mining companies have for some time past had a plant for lighting, and there is not much trouble in convincing them to supplement it with an equipment of electric motors.

Wiring Recommendations of the Boston Electric Light Committee.—Since the recent fire in Boston considerable attention has been paid to the question of carrying wires into buildings, and the insulation of interior wiring. A committee recently appointed on the subject has presented a set of recommendations to the inspector of buildings in that city, and it is likely that most, if not all, of these recommendations, will go into effect. It is to be noticed that one section says: "Wires laid in plaster, cement, or other similar building material will not be allowed, no matter what insulating covering may be used. In lieu of construction by air space and non-combustible insulators, wires may be encased in insulating tubing that is impervious to moisture, will not support combustion, and of sufficient mechanical strength to protect them from injury, and such tubes may be laid side by side in plaster, cement, or other similar finish, or in any concealed space where they will not be subjected to injury, and may be supported by staples or such other means as shall not injure the tubing." It is provided also that every telephone, telegraph messenger service, or other wire, both ingoing and outgoing, shall be provided with safety fuses located as near as possible to the place where the wires enter the building, and at some point easy of access. I might add that no evidence has yet been adduced to show that the recent big fire in Boston was of electric origin.

Destruction of the Edison Station in Pearl-street.—I am sorry to have to make a note, however, of the fact that on Thursday morning of this week the old Edison station in this city down town—the first central station installed in America for the supply of incandescent lighting—was destroyed by fire. No exact account of the accident has yet been given out. It is stated that it occurred in the vicinity of the boiler room, but another account says that it was due to a short circuit outside the station which set one of the dynamos sparking violently, and ignited the oil, setting fire in turn to the old oil-soaked wooden floor. The station had been in use since 1883, and was very little like our ideal of a modern station, and about as far removed as possible in convenience, safety, and economy from the new Edison stations up town. The fire was not long in spreading through the building, and in destroying plant to the value of at least $100,000. A good deal of the load was immediately taken over by the other Edison down town station in Liberty-street. Another reason why the deprivation of light is not so severely felt is that nearly all of the very large buildings in the vicinity of the station have their own isolated plants. Funnily enough, one of the newspapers this morning gives a list of the buildings which it says have been deprived of light by the fire, and in every case but one the building has its own plant. I have cited this simply as an example of the newspaper accuracy which we have to contend with. I hear that it was recently decided by the local Edison Company, although they were well aware of the hazardous condition of their Pearl-street station, not to rebuild it at present, but to take their chance, and to push forward for the newer work in the residential portions of the city. Probably they regret this decision just at present. In some quarters there is a disposition to feel pleased to see Mr. Edison, after the recent exposition of his views on the dangers of electricity, "hoist with his own petard;" but as a rule I believe the electricians here recognise their community of interest, and are sorry to see anything occur which at this juncture can be brought up and paraded as a means of scaring the public, and spreading an idea as to the undesirability of the electric light.

Electrical Execution.—We seem to be somewhat nearer than we were to the infliction of the sentence of death by electrical execution. A decision, confirming the order which dismissed the writ of Habeas Corpus as to one of the murderers now under sentence of death has been handed down by the General Term of this State, and if nothing intervenes the execution will soon come off. The new decision admits that the sentence of electrical execution is somewhat unusual, but holds that it is not necessarily cruel, and fails to find that any facts have been established showing the new law to be unconstitutional. It says that the evidence adduced is clearly in favour of the conclusion that it is within easy reach of electrical science at this day to so generate and apply to the person of the convict a current of electricity of such nature and sufficient force as certain to produce instantaneous, and therefore painless, death. It is said that Mr. Bourke Cockran, who has been fighting this matter on behalf of the criminal in question, will carry the case to the final Court of Appeals, where he is hopeful of obtaining a reversal of the opinion. In the meantime it looks as though the criminals in this State now under sentence of capital punishment would shortly have the sentence inflicted upon them. In this view of the case, some medical and other experts, including

Digitized by Google

one whom it is unnecessary to name, have made a further trial of the apparatus installed for the purpose, and they have satisfied themselves that it will work to perfection. At this last trial they took one or two animals and shocked them to death, and then tried to resuscitate them, but in vain. The object in this experiment was to prove that there would not be any likelihood of a defeat of justice by what is known as "suspended animation." It is a great pity that the animation of our murderers cannot be suspended in the old-fashioned, ordinary way.

PARIS NOTES.

(FROM OUR CORRESPONDENT.)

January 14, 1890.

You have already, I believe, alluded on several occasions to the vigorous attack of MM. Dandeu and Naze on the Ferranti alternators at the Halles Centrales, and I think a brief account of the whole affair may not be without interest to your readers. The last move of these gentlemen has been to induce the Conseil Municipal to pass the following resolution:—The Commission Technique is invited to ascertain whether the various electric supply companies have complied with the clause in their concessions relating to the employment of foreign material, and the Commission Technique is therefore requested to visit the several generating stations and carefully inspect the whole apparatus. The members of the Commission Technique are to meet to-day, and will have to decide whether or not they shall comply with the demands of the municipal authorities and undertake the invidious task of spying.

M. Dandeu, as some of your readers may recollect, is a former workman and foreman of the late M. Gaulard. He subsequently went into partnership with M. Naze, manager of the Tours Gaulard-Gibbs transformer station, and the result of this association was the Dandeu-Naze alternator. A rough-and-ready machine was built for them by MM. Weyher et Richemond, and they then posed as candidates for the supply of dynamos to the station at the Halles Centrales. MM. Potier, Hospitalier, and Carpentier were instructed to test this new alternator, but the day originally fixed for the trial having been changed, M. Hospitalier's place was taken by M. Laffargue. At the end of an hour and a-half's run a heated bearing necessitated the stopping of the machine. It was started again, and yielded 40 amperes and 1,600 volts, but after a further run of two hours the heating of the machine brought the trial to an end. The temperature of the air space (which was 3cm. deep) was then 67° C (153° F). The result of this test was naturally an adverse report. Hence the invectives and accusations of the designers. At the present moment MM. Dandeu and Naze have fallen out, so that we may hope to hear no more of these groundless complaints.

The Municipal Station at the Halles Centrales has commenced to supply current to private consumers. The Khotinsky and Gabriel incandescent lamps are the most used, the Froger meter being employed to measure the consumption. The Société Anonyme pour le Transport de la Force (Marcel Deprez) has begun to lay the mains connecting the Rue de Bondy and Saint-Ouen stations. The method employed is the same as that in vogue on the Grande Boulevards, namely, bare copper conductors run on porcelain insulators and placed in cement conduits. A new company, the Compagnie Internationale d'Électricité, has just been formed here to work the patents of M. Pieper. Two of the main streets of Paris are shortly to be lighted by incandescent lamps and regenerative gas lamps respectively. The comparative value of the two systems will then be thoroughly investigated, and whichever proves itself the superior will be adopted for all the main thoroughfares of Paris. The Public Lighting Budget of the Conseil Municipal will thus be augmented by 150,000fr. Of this sum 50,000fr. will be devoted to improving the gas lighting and 100,000fr. to extending electric lighting.

CORRESPONDENCE.

THE "ECONOMIC RATIO" OF A TRACTION SYSTEM.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to Dr. Louis Bell's Paper on a test of the new Sprague motor, published in the last number of *The Electrician*, I should like to ask that gentleman by what process of reasoning he comes to the conclusion that, in computing the "economic ratio" of a traction system, the weight of the car should be reckoned in with the useful load. It is quite evident from the figures that he gives that he does so, and in fact I remember that in a former Paper on the same subject he defends this course by stating that the weight of the car is a necessary weight, and therefore must be included in the useful weight. Surely if the meaning of words is to go for anything, this reasoning should logically lead him in the other direction. In any case, if Dr. Bell is correct, I should like to point out to him that there is a method of increasing the economic ratio that is far simpler than seeking to improve motors, and that is by increasing the weight of his car. If he only makes this high enough he can make his economic ratio as near unity as he pleases.

Surely a fairer way would be to call the ratio of the weight of passengers to total weight the economic ratio. The figures would then be:—For a car of 3,000lb., motor 4,400lb., and passenger load 4,000lb., economic ratio = ·35. If the motor were reduced in weight to 2,500lb., the economic ratio would become ·42, and thus a decrease in motor efficiency in the ratio of 6 to 5 would still leave the ratio of receipts to working expenses the same. Still, it by no means follows that the dividend-earning capacity would be unaltered, as, of course, capital outlay is a factor in the determination of the latter.

Apologising for trespassing so much on your valuable space, for which the great attention that is now being given to electric traction in this country must be my excuse,—Yours, &c.,

18, Stanley-road, Wimbledon, H. J. S. HEATHER.
January 10, 1890.

AN ALTERNATE CURRENT "TRANSMUTER."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Your recent illustration and description of Bernstein's continuous-current transformer, used with his constant-current system, and Prof. Robinson's recent advocacy of a similar device, induce me, a reader of your journal, to put before you a suggestion which has been long in my mind, and might be worthy of the attention of electrical engineers. It is that where the alternating current is used for distribution, customers might be provided, at their option, with a transformer (or "transmuter," for some other name would be desirable) which would convert the alternating current into a continuous one, and thus enable those who wished to do so, to charge accumulators on their premises, and do other work for which alternating currents are useless. I believe there are already alternate-current motors which, coupled to small continuous-current dynamos, would effect the object in view. Self-starting would not be a necessity, for one lamp always burning would ensure the constant running of the transformer; and if this were undesirable, or the distributing current were interrupted, the starting would be no more trouble than the turning on of gas at the main, as is done every day in some establishments. If the same idea has occurred to others, their views on the subject would, I think, be of interest to your readers.—Yours, &c., R. LANGTON COLE.

24, Finsbury-circus, E.C., January 10, 1890.

WILLIAM STURGEON.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Will you kindly permit me to inquire through your columns whether any of your readers is cognisant of the existence of any portrait of William Sturgeon, the inventor of the electro-magnet, who died in 1850. He was long resident at Woolwich, lectured on electricity at the Adelaide Gallery and other places in London, and afterwards removed to Manchester. He founded the short-lived Electrical Society of London, and was the editor of the "Annals of Electricity." Any personal information respecting him or his writings would be very gratefully received by,—Yours, &c., SILVANUS P. THOMPSON.

20, Arundel-gardens, W.

Postal Telegraph Revenue.—The total receipts from the telegraph service from April 1, 1889, to January 11, 1890 amount to £1,820,000, against £1,640,000 for the corresponding period—an increase of £180,000.

Digitized by Google

DRAFT BOARD OF TRADE ELECTRIC LIGHT REGULATIONS.

The following is a copy of the draft regulations now being prepared by the Board of Trade for securing the safety of the public and for ensuring a proper and efficient supply of energy :—

Definitions.

In these regulations—

The expression "the undertakers" shall mean the undertakers for the purpose of the Order.

The expression "consumers' wires" shall mean any electric conductors on a consumer's premises which are connected with the service lines of the undertakers at the terminals at which energy is delivered to such consumer.

The expressions "low pressure supply," "high pressure supply," and "extra high pressure supply," are used in these regulatians with reference to the difference of electrical potential between the two conductors through which the supply of energy is given, or between any part of either conductor and the earth ; a difference of potential on any alternating current system being taken to be the equivalent of a difference of potential on a continuous current system, when it produces an equal heating effect if applied to the ends of a thin stretched wire or carbon filament ; that is to say :—

(*a*) Where the conditions of supply are such that the difference of potential, as above described, cannot at any time exceed 300 volts, if the supply be on a continuous-current system, or the equivalent of 150 volts, if the supply be on any alternating-current system, the supply shall be deemed a low-pressure supply.

(*b*) Where the conditions of supply are such that the difference of potential, as above described, may exceed the limits of a low-pressure supply but cannot exceed 3,000 volts, or the equivalent of 3,000 volts on either system, the supply shall be deemed a high-pressure supply.

(*c*) Where the conditions of the supply are such that the difference of potential, as above described, may on either system exceed 3,000 volts or the equivalent of 3,000 volts, the supply shall be deemed an extra high-pressure supply.

Mains, service lines, and other conductors and apparatus are referred to as low-pressure, high-pressure, and extra high-pressure mains, &c., according to the conditions of the supply delivered through the same or particular portions thereof.

I.—Regulations as to Safety.

General.

1. Save as hereinafter provided, the supply of energy delivered to the terminals on the consumer's premises shall be low-pressure supply.

2. A high-pressure supply shall not be delivered to the terminals on any consumer's premises except for special purposes, and with the approval of the Board of Trade, on the joint application of the consumer and the undertakers, and subject to such further regulations as the Board of Trade may from time to time prescribe.

3. An extra high-pressure supply shall not be given except to distributing stations or other premises in the sole occupation of the undertakers, and with the written consent of the Board of Trade, and subject to such conditions as the Board may prescribe.

3A. The undertakers shall provide and fix, to the satisfaction of the Local Authority, such appliances or apparatus as the Board of Trade may from time to time consider advisable, whether for safety or for the prevention of the limits of difference of potential above stated, or such other limits as may from time to time be fixed by the Board of Trade in place thereof, either generally or in particular cases, from being exceeded ; and sealed patterns of any such appliances or apparatus shall be deposited at the office of the Local Authority.

Mains and other Conductors.

4. The maximum working current in any conductor used in connection with the supply of energy shall not be sufficient to raise the temperature of the conductor in any part to such an extent as to materially alter the physical condition or specific resistance of the insulating covering, if any, or in any case to raise such temperature to a greater extent than 30 degrees of Fahrenheit's thermometer, and efficient automatic means shall be provided, which shall render it impossible for this maximum working current to be by any accident exceeded to the extent of 25 per cent., even for short intervals of time ; and special care shall be taken that the cross-sectional area and conductivity at joints are sufficient to avoid local heating, and that the joints are protected against corrosion.

5. Conductors used for a high-pressure supply shall be either separately or collectively completely enclosed in wooden pipes or casing, not less than one-quarter of an inch in thickness, placed in efficient connection with the earth, either throughout their length, or at points not separated from each other by more than 100 yards. Provided that where the conductors pass through any junction or draw box, which is not also used for low-pressure conductors, the portions so passing through such junction or draw box need not be so closed.

6. Every conductor used for a high-pressure supply must be continuously insulated with a durable and efficient material, to be approved by the Board of Trade ; and the insulation resistance of any high-pressure conductor, including joints, shall not be permitted to fall below 50 megohms per mile. This insulation must be further efficiently protected on the outside against injury or removal by abrasion. Provided that when one of the two conductors forming the line and return for any circuit or part of a circuit completely encloses the other conductor, the outer conductor, if efficiently connected to earth at the source of supply, need not be continuously insulated except to such extent as may be necessary to avoid disturbance to other lines or works.

7. Except where concentric conductors are used as provided in the preceding regulation, the insulation resistance of any complete circuit used for high-pressure supply, including all devices for producing, consuming, or measuring energy, connected to such circuit, shall be such that should any part of the circuit be put to earth, the leakage current shall not exceed $\frac{1}{15}$th of an ampere in the case of continuous currents, or $\frac{1}{10}$th of an ampere in the case of alternating currents. Every such circuit used for high-pressure supply shall be fitted with an indicating device, which shall continuously indicate if the insulation resistance of either conductor fall below the conditions required by this regulation.

8. In the case of a high-pressure supply on any alternating current system, where separately insulated conductors are used, precautions shall be taken against the discharge of electric sparks between the insulating covering of oppositely charged conductors by providing a sufficient connection of a conducting nature between these coverings throughout.

9. Where any portions of any conductors belonging to the undertakers are exposed in such a position as to be liable to be struck by lightning they shall be sufficiently protected by appliances of such pattern and construction as may from time to time be prescribed or approved by the Board of Trade.

Conduits.

10. All conduits used as receptacles for conductors shall be formed of durable material and of ample strength to resist any reasonable pressure due to heavy traffic, or other forces to which they may be subjected.

11. Where the conductors in any circuit are not sufficiently insulated, the conduit must be efficiently drained, so that no accumulation of water can take place in any part sufficient to raise the level of the water into contact with the conductors.

12. All conduits for conductors laid in streets, in which gas mains are also laid, must be thoroughly ventilated, or otherwise efficiently protected against an accumulation of gas.

13. All street boxes, manholes, junction and draw boxes must be efficiently drained and ventilated, and their covers so secured that they cannot be opened except by means of a special appliance.

Distributing Stations.

14. Distributing stations to which a high-pressure supply is given from generating stations, and from which a low-pressure supply is given to consumers, must be established on suitable premises in the sole occupation of the undertakers ; and the supply from such stations must be constantly controlled by a skilled person in the service of the undertakers, and printed directions must be conspicuously exhibited in every station, providing for the action to be taken by such person in charge in any emergency, the occurrence of which may be reasonably considered possible ; and these directions shall be submitted for the approval of the Board of Trade.

15. In every case where the supply is transformed at a distributing station, as described in the preceding regulation, means must be provided to the satisfaction of the Board of Trade, which shall render it impossible that the low-pressure mains shall be at any time charged to a dangerous difference of potential to the earth, owing to any accidental contact with the high-pressure system either within or outside the distributing station.

Consumer's Premises.

16. Where the general supply of energy is a high-pressure supply, and transforming apparatus is installed on the consumer's premises connected to the distributing mains by high-pressure service lines, and to the terminals by low-pressure service lines, the whole of the high-pressure service lines, conductors, and apparatus, including the transforming apparatus itself, so far as they shall be on the consumer's premises, shall be completely enclosed in metal casing not less than one-quarter of an inch in thickness, efficiently connected to earth, and every portion of such casing shall be securely fastened.

17. In any case where any transforming apparatus is installed on the consumer's premises, as described in the preceding regulation, means must be provided to the satisfaction of the Board of Trade, which shall render it impossible that the low-pressure service lines and consumer's wires shall be at any time charged to a dangerous difference of potential from the earth, owing to any accidental contact with the high-pressure system either within or outside the transformer.

18. All terminals, low-pressure service lines, or other apparatus between the terminals, and the transforming apparatus, or other source of supply so far as they shall be on the consumer's premises, shall be completely enclosed in insulating cases or coated with insulating material in such a manner that no part of them can be touched by any person without the removal of such case or coating ; and they shall be, wherever exposed, efficiently protected against injury to the insulation.

19. The energy shall be delivered to the consumer's premises in some manner free from the risk of causing fire on the premises in question, whether such fire should or might be originated during or in consequence of a proper or improper supply of energy or by reason of the cessation of any supply, or should or might be partly due to any defective action of the lamps, motors, storage cells, conducting wires, transformers, or other fittings connected with the terminals for the purpose of using the supply of energy.

20. If the undertakers are reasonably satisfied, after making all proper examination, by testing or otherwise, that a connection with the earth exists at some part of a circuit of such resistance as to be a source of danger, and that such connection does not exist at any part of the circuit belonging to the undertakers, then and in such case any officer appointed by the undertakers, and duly authorised by them in writing, may, for the purpose of discovering whether such connection with the earth exists at any part of a circuit within or upon any consumer's premises, at all reasonable times, after giving one hour's notice of his intention to do so, enter any

Digitized by Google

such premises and disconnect the consumer's wires from the terminals of the service lines, and may require the consumer to permit him to inspect and test the wires and fittings belonging to the consumer and forming part of the circuit.

21. If on such testing the officer discovers that a connection exists between the consumer's wires and the earth, and that such connection has an electrical resistance not exceeding 5,000 ohms, or if the consumer does not give all due facilities for such inspection and testing, the undertakers shall forthwith discontinue the supply of energy to the premises in question, giving immediate notice of such discontinuance to the consumer, and shall not recommence such supply until they are reasonably satisfied that such connection with the earth has been removed.

22. If any consumer is dissatisfied with the action of the undertakers, either in discontinuing or not recommencing the supply of energy to his premises, the wires and fittings of such consumer may, on his application, be tested for the existence of connection with the earth by an electric inspector; or if no electric inspector has been appointed, by a person appointed by the Board of Trade. For the purposes of such testing, the provisions of the order as to the testing of service lines shall, with the necessary modifications, apply to the testing by such inspector or person of the consumer's wires and fittings under these regulations.

Penalties.

23. If the undertakers make default in complying with any of the preceding regulations, they shall be liable to a penalty not exceeding £20 for every such default, and if they fail to discontinue the supply of energy to any consumer's premises upon discovery of connection with the earth, or if they recommence such supply before being reasonably satisfied that no such connection, having such electrical resistance as aforesaid exists, they shall be liable to a further penalty, not exceeding £20, for every day during which such offence continues.

The imposition of any penalty under this regulation shall not affect the liability of the undertakers in respect of any damage or injury which may be caused by reason of such default.

II.—Regulations as to Supply.

1. One week, at least, before the undertakers are ready to commence to supply energy through any feeding, charging, or distributing main or mains, they shall serve a notice upon the Local Authority of their intention to commence such supply.

2. From and after the time when the undertakers commence to supply energy through any distributing mains, they shall maintain a supply of sufficient power for the use of all the consumers for the time being entitled to be supplied from such main, and such supply shall, except so far as may be otherwise agreed upon from time to time between the local authority and the undertakers, be constantly maintained at such pressure as may be fixed under the provisions of these regulations. Provided that, for the purposes of testing, the authority by whom the electric inspector is appointed, may give permission to the undertakers to discontinue the supply at such intervals of time and for such periods as it may think expedient, and that for any other purposes connected with the efficient working of the undertaking, the undertakers may, with the permission of the Board of Trade, discontinue the supply at such intervals of time and for such periods as the Board of Trade may think expedient. Where the supply is so discontinued, notice of such discontinuance, and of the probable duration thereof, shall in every case be forthwith served upon the Local Authority

3. The system of distributing mains must be so arranged that in case it becomes necessary to stop the supply through any portion of a main for a longer period than one hour, owing to the execution of repairs, or for any other reason, the amount of supply so stopped shall in no case exceed a maximum power of 100,000 watts; and in no such case shall it be necessary to cut off the supply to more than 40 houses or tenements.

4. During the whole of a period when a supply of energy is required to be maintained by the undertakers in the distributing mains, under the order and these regulations, it shall be given at a constant pressure (in these regulations termed "the standard pressure") to be fixed as hereinafter specified. Provided that the undertakers shall be deemed to have complied with the requirements of this regulation, so long as the pressure does not at any point vary more than 3 per cent. from the corresponding standard pressure in the case of a general supply at low pressure, or 2 per cent. in the case of a general supply at high-pressure, unless changes in pressure recur so frequently as to cause unsteadiness in the supply.

5. The standard pressure may be different for different points of any pair of distributing mains but it shall not be such as to cause a difference of potential after transformation of energy if required at any pair of terminals on the consumer's premises of more than 115 volts, or the equivalent of 115 volts, or less than 45 volts, or the equivalent thereof. And in distribution, on the three-wire system, the central main shall be considered to form a pair with either of the outside mains, and similarly for multiple wire systems.

6. In the case of transformation of energy on the consumer's premises, the undertakers shall give the consumer the choice of a supply at either of two different pressures, one of which shall be approximately half the other.

7. The standard pressure shall be fixed by the undertakers for every pair of distributing mains, and notice of such amount of such standard pressure shall be given to the Local Authority before the undertakers commence to supply energy to consumers through such mains, and shall not be altered except by permission of the Local Authority, and upon such terms and conditions as the Local Authority may impose, and after public notice has been given during a period of one month, in such manner as the Local Authority may require, of the intention of the undertakers to apply for permission to alter the same. Provided that the undertakers may appeal against any decision of the Local Authority, under this regulation of the Board of Trade, whose decision shall be final.

8. The supply of energy upon any premises shall (except by agreement) be given by one or more pairs of terminals situated thereon, the respective terminals of each pair being situated at a safe and convenient distance from one another, and being in connection, respectively, with the positive and negative mains; and the undertakers shall be responsible for the maintenance of such terminals, and any other lines, fittings, and apparatus belonging to the undertakers, or under their control, upon such premises in a fit and proper condition for supplying energy.

9. The variation of pressure at the supply terminals on any consumer's premises shall not, under any conditions of supply, which the consumer is entitled to receive, nor at any time, exceed 4 per cent. from the mean pressure, whether such variation be due to the resistance of the service lines or apparatus belonging to the undertakers, or to any action or effect produced by such apparatus, for which the consumer cannot be shown to be responsible, or, partly to any variation of pressure in the distributing mains from which the supply is taken.

10. If the undertakers make default in complying with any of these regulations as to supply, they shall be liable to a penalty not exceeding £5 for every such default.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning.*]

Tenders Invited.—It will be seen from our advertisement columns that the Lighting Committee of the Local Board for the district of Bridlington are prepared to receive tenders for the lighting of the public streets and places within their district, by electricity or gas. Tenders must reach Mr. Charles Gray not later than Monday, January 27th.

——— The Lea Bridge, Leyton and Walthamstow Tramways Company are prepared to receive tenders for electric haulage in place of horses, provided any company or association of repute will undertake to carry out the service and guarantee due performance under proper conditions and at a fair price. Further particulars will be found in our advertisement pages, and full information can be obtained of Mr. J. B. Glenn, secretary to the company, at No. 7, Poultry, London, E.C.

The Electrical Engineering Corporation (Limited).—An amalgamation has been arranged between Messrs. J. G. Statter and Co. (Limited) and the United Electrical Engineering Company (Limited), the joint concern to be known in future as the Electrical Engineering Corporation. The Corporation has taken over the interests and responsibilities of both companies as and from the 1st inst. The Corporation is thus a manufacturing and supply undertaking, having exceptional facilities for co-operating with contractors and others in carrying out work at home and abroad in all branches of the electrical industry. The Alliance Engineering Works at West Drayton are within fifteen miles of London, on the main line of the Great Western Railway, and have a dock and wharf upon the Grand Junction Canal, the works are already extensive and complete, and when the extensions now in progress have been completed they will cover about four acres of ground, and contain some of the largest machine tools employed in the trade. The situation of the works is favourable for the economical despatch of material both for home and foreign use. The Albert Works (36, Albert-embankment, S.E.) are devoted to the manufacture of switch, safety junction, and regulator gear, together with other fittings and accessories suitable for a wide range of electrical work. The London offices are centrally situated, being at Prince's Mansions, 68, Victoria-street. The managing directors of the corporation are Messrs. J. G. Statter, Edward Manville, and William L. Madgen.

Dissolution of Partnership, &c.—We have received from Messrs. Gent and Co., of Leicester, the following notice:—"We desire to inform you that the partnership hitherto existing between Messrs. J. T. Gent and H. G. Ellery has this day been dissolved by mutual consent. All debts will be received and paid by Mr. J. T. Gent." This notice is accompanied by the following, signed by Mr. J. T. Gent:—"I have pleasure in informing you that I have this day taken into partnership Mr. A. W. Staveley and Mr. I. H. Parsons, and that the business will be continued under the usual style of Gent and Co., Electricians."

The Electric Welding Syndicate.—Permission to view the electric welding process may be obtained on application to Mr. William Bevan, secretary *pro tem.*

Swinburne and Co.—This firm report that they have already received orders for some of their new open-circuit or "Hedgehog" transformers for town installation work. Messrs. Swinburne are sanguine as to the success of this transformer, and are making preparations to turn them out on a large scale. They intend shortly to introduce a new non-induction watt-meter for alternating or con-

Digitized by Google

tinuous currents. The "Hedgehog" transformer is made to a number of stock sizes, from 25 30-watt lamps to 1,000 30-watt lamps, and other sizes can be made to order. Advantages claimed are that the transformer is perfectly insulated, and does not get hot.

THE ELECTRIC CONSTRUCTION CORPORATION.—We have received some neatly-printed sheets of price lists of Elwell-Parker 50-volt, 60-volt, 80-volt, 100-volt, and 135-volt continuous-current dynamos, of accumulators, glass insulators, and hydrometers. The tables given show at a glance the electrical output, dimensions, and prices of each of the above dynamos, as well as the approximate speeds in revolutions per minute. These sheets are in a very handy form.

MESSRS. FOWLER, LANCASTER, AND CO. (LIMITED).—We have received from this firm a copy of their new catalogue just issued, which contains a number of illustrations of batteries, bells, indicators, fire alarm telegraphs, time controllers, telegraph instruments, telephones, lightning conductors, switches and keys, electric pulls and pushes, burglar alarms, electro-medical appliances, small dynamos and motors, electric gas lighters, testing apparatus, lineman's tools, insulators, compasses, barometers, hydrometers, thermometers, contact pillars, terminals, nuts, and connectors. These illustrations are accompanied by full descriptions as to price, &c. Some interesting notes are given on electrical bell communication and instructions for their proper fixing. The catalogue is neatly got up, has a full index, and consists in all of 60 quarto pages. Messrs. Fowler, Lancaster and Co. announce that other catalogues are now in the press dealing with every electrical requisite for contractors, &c., &c.

ELECTRIC LIGHT ENGINES.—We have received the engineering section catalogue just issued by Messrs. Ransomes, Sims, and Jefferies. It consists of 80 quarto pages, fully illustrating the well-known types of engines manufactured by this firm. On pages 8 and 10 are shown new designs of portable engines with one cylinder, in the first of which the guide bars, of the circular type, are formed in one casting of the cylinder, and in the second are embodied all recent improvements. To meet a growing demand, Messrs. Ransomes, Sims, and Jefferies have adapted the boilers of their portable engines so that oil can be used as readily as any other fuel. The illustration on page 13 of the catalogue shows the general arrangement of a portable steam engine fitted with the petroleum burning apparatus. The apparatus consists of a supply tank for holding a certain quantity of petroleum, which is placed above and at the side of the fire-box of the engine, and an arrangement of pipes for conducting the petroleum and super-heated steam to the special burner in the furnace. The fire-box, which is of extra large dimensions, can be readily changed by the addition of other parts from a petroleum-burning furnace to either a straw, wood, or coal burning furnace. An example of the straw-burning engine is shown on page 14 in section and perspective. On pages 18 and 20 are shown examples of high-pressure engines specially recommended for electric lighting, being fitted with the firm's patent automatic governor expansion gear. On page 28 an illustration appears of the patent gear with which all engines built by this firm specially for electric lighting purposes are fitted, an illustrated description of which recently appeared in *The Electrician*. The catalogue contains a large number of illustrations and descriptions of all kinds of engines, all of which are fitted with the most recent improvements. The concluding illustration is a fine view of the company's large works at Ipswich, covering 13 acres, and employing between 1,200 and 1,400 hands.

BOOKS, &c., RECEIVED.

"The Uses of Electrolysis in Surgery." By W. E. Steavenson, M.D. (London: J. and A. Churchill.)

"The Year-Book of Photography." (London: Piper and Carter.)

"Leçons sur la Théorie Mathématique de l'Électricité." By J. Bertrand. (Paris: Gauthier-Villars et Fils.)

"A Guide for the Electric Testing of Telegraph Cables." By Colonel V. Hoskier. Third Edition. (London: E. and F. N. Spon.)

"Journal of the Institution of Electrical Engineers." Vol. XVIII., No. 82. (London: E. and F. N. Spon.)

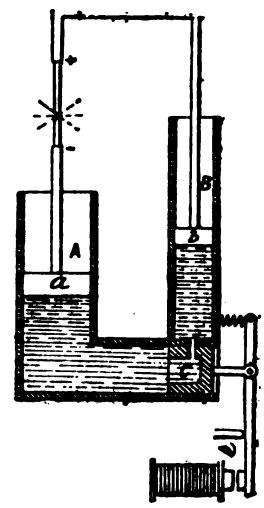
"Traité Élémentaire de l'Energie Électrique." Vol. I. By E. Hospitalier. (Paris: G. Masson.)

"Electric Light Installations and the Management of Accumulators." By Sir David Salomons, Bart. (New edition, revised and enlarged.) (London: Whittaker and Co.)

THE STOCHER-SEDLACZEK ARC LAMP.*

The principle of the Stocher-Sedlaczek arc lamp is the same as that of MM. Lacassagne and Thiers described in *The Electrician* of November 15th; but the liquid employed is glycerine instead of mercury. In the accompanying figure we have a diagrammatical representation of the apparatus.

The two vertical cylinders A and B are in communication with each other through a horizontal cylinder. The piston *a* carries the negative carbon holder, the piston *b* the positive carbon holder; the function of the third piston *c* being to establish and interrupt communication between the cylinders A and B. An electro-magnet placed in the main circuit, by influencing an armature connected to the piston *c*, actuates the latter. When the action of the electro-magnet weakens, a spring causes the armature, and consequently the piston *c*, to move in the reverse direction.



The Stocher-Sedlaczek Arc Lamp.

On the circuit being closed, the armature is attracted, and the piston *c* moves from left to right, cutting off communication between A and B, and causing piston *a* to fall and strike the arc. When the current weakens by reason of the lengthening of the arc, the spring overcomes the attraction of the electro-magnet upon its armature, and the piston *c* is moved from right to left, communication between the two vertical cylinders is restored, liquid flows in from B to A, and the arc is reduced to its normal dimensions. The diameters of the cylinders A and B are proportioned so as to give the arc a fixed position. This lamp can be employed with advantage on locomotives, the light remaining very steady even when exposed to severe oscillation.

COMPANIES' MEETINGS & REPORTS.

The Eastern Telegraph Company (Limited).

The 35th half-yearly ordinary general meeting of this Company was held yesterday (Thursday) at Winchester House, Old Broad-street, E.C., under the presidency of Sir John Pender, K.C.M.G.

The SECRETARY (Mr. George Draper) having read the notice calling the meeting, the following report of the Directors was taken as read:—

1. These accounts and balance sheet are for the six months ended September 30, 1889.

2. The revenue for the period amounted to £351,014. 19s. 4d., from which are deducted £87,730. 15s. 9d. for the ordinary expenses and £49,634. 11s. 6d. for expenditure relating to repairs and renewals of cables, &c., during the half-year. After providing £4,724. 10s. 11d. for income-tax, there remains a balance of £208,925. 1s. 2d., to which is added £974. 15s. 6d. brought from the preceding half-year, making a total available balance of £209,899. 16s. 8d.

3. From this balance there have been paid—

Interest on Debentures and Debenture Stock	£28,274	12	7
Dividend on Preference shares	20,474	2	8
Two interim dividends of 2s. 6d. per share each on ordinary shares	100,000	0	0
	£148,748	15	3

Leaving a balance of £61,151. 1s. 5d., which is carried forward to the next account.

* Translated from M. Hippolyte Fontaine's "Éclairage à l'Électricité," by kind permission of the Author.

Digitized by Google

4. The revenue includes £37,318. 4s. 11d. dividend for the half-year upon the Company's shares in the Eastern and South African, the Black Sea, and the Direct Spanish Telegraph Companies. The cables of these Companies are in good working order.

5. All the sections of the Company's cables, without exception, are in good working order.

6. During the past six months, in consequence of the political disturbances in the Island of Crete, the telegraph lines on the island were interrupted.

The Directors applied to the Turkish Government for permission to lay a duplicate cable between Canea and Candia, a distance of 70 knots, which was required for the increased amount of traffic thrown upon the Company's cable by the interruption to the land lines. As it was of the greatest importance to the Turkish Government that telegraphic communication should be efficiently maintained between the Porte and Crete, the Firman was at once granted and the cable laid, the cost of which has been charged to the reserve fund.

To meet the requirements of the increased traffic new cables have been laid connecting Patras with Corinth (75 knots) and Piræus with Kalamaki in the Gulf of Athens (31 knots). The cost of these cables has also been charged to the reserve fund, as well as that of the Perim-Oboch cable referred to in the last report. The laying of this cable was completed on July 17th

7. In accordance with the Articles of Association, two of the Directors, George Garden Nicol, Esq., and John Denison Pender, Esq., retire by rotation at this meeting, and, being eligible, offer themselves for re-election.

8. The auditors, Mr. Henry Dever and Messrs. Welton, Jones, and Co. retire, and offer themselves for re-election.

The CHAIRMAN said that the gross revenue for the half-year ended September 30th had been £351,014, or an increase of £40,910 compared with the corresponding period of the previous year. That was a very handsome increase, and about £29,000 was derived from messages and £12,000 from additional dividend on the Company's increased holding in the Eastern and South African Company. Those figures showed that the revenue for the half-year had been exceptional, and they hoped that the improvement would continue. He might remind them of what he had frequently said before, that the revenue of the Company depended in a great measure on the state of the trade of the country. As he had frequently said, the submarine telegraph system was about the best barometer of trade, and while they all admitted that commercial prosperity had prevailed throughout the world, the result of the past half-year's working showed that the Company had participated in the improved state of things. The greater part of the increase had been caused by the development of business in South Africa, but it was pleasing to note that with one exception — namely, India — an increase had taken place in all classes of their traffic owing to the general improvement of trade both at home and abroad. The general prosperity of the country affected almost every article which was dealt in, and all the materials required to make cables had enormously increased in price. The total working expenses of the half-year had been £87,730, being an increase of £4,398. The general expenses in London had been £566 more, owing to the steady increase of their business requiring more hands, additional accommodation, &c. The working expenses at the stations had been £64,712, being an increase of £4,750 over those of the same half of 1888. There had been an increase of 40 in the number of the staff, and they had given increases of salary to their principal *employés*, more particularly the superintendents abroad. Repairs to cables had cost £49,634, or £6,569 more, full details of which would be found in Abstract "C" of the accounts, which was really a very interesting abstract. It showed the expenses of their steamers and also the improvements which were being made in their property. The steamers moved about from place to place conducting the repairs in the most silent way possible, and their system was now almost as perfect as it was possible to make it. He had often stated that a single line of telegraph was not to be relied on. Unless they had a duplicate line they could not give that confidence required by merchants, who depended on the cables for carrying through their large mercantile operations. Only the other day the submarine telegraph system was regarded as the great feature of the age in politics, but he held that it was a still greater feature now in connection with commerce. They did not profess to go in for extreme dividends, but they had endeavoured to put by such an amount as would secure not only the present position, but build up great security for the future; and as they strengthened their foundations so they would be able in the future, he hoped, to increase their dividend. They carried forward to the credit of next account over £61,000. If they were as successful in the current half-year as they had been in the six months under review, the shareholders might expect a satisfactory bonus. Africa was now being opened up, and last year they completed a circuit of the whole of that dark continent, and that was the greatest operation which had ever been carried out in connection with submarine telegraphs, involving, as he had said at the last meeting, something like 17,000 miles of cable. While other countries were striving hard to get a footing in Africa, this Company were the pioneers, and had put themselves in such a position that at every point of the seaboard they were in communication with the old country. The English-speaking people, it might be said, had developed Africa up to the present point, and as long as the English tongue and the enterprise which followed it continued, they had a wide field for development in Africa. Portugal had behaved generously to the Company. If that country had shown the same enterprise as England, it would now have very large claims in Africa; but having held a position for a very long time there, they had allowed matters to remain dormant. However, as he had said, Portugal had helped them, France had to some extent, and so had Spain; but, curiously enough, the only country that had not assisted them in any way was Germany. Germany was now trying to get a hold in that country, but they found that they could not do so without doing something for submarine telegraphs. Inquiries were now being made on the part of Germany in connection with that matter, and he hoped that when they next met he would be able to state that Germany was now taking her part in connection with submarine telegraphy, which was doing so much for the good of the whole world. Their policy had been as far as possible to follow the trade and flag of England. Africa was now in a state of transition. There were two imperial British companies there in the hands of bold, intelligent and large-minded men, and there was no doubt there would be rapid development there. Without hesitation, therefore, the Company had laid down (he believed the cable was completed to-day) a cable from Zanzibar to Mombassa, the head-quarters of the Imperial East African Company, which was working under a royal charter. That section would put them in communication with the whole of the civilised world. To borrow a phrase, he might say they were on very friendly relations with every Government in the world. Recently the Emperor of Morocco visited Tangiers, where the Company had landed a cable, and His Majesty was so pleased with what he saw that he presented them with a site to build an office upon, as an evidence of goodwill towards the Company. The Sultan of Zanzibar had also given them a site and a house for their station, as well as every possible facility. Two days ago they had concluded with France agreements which would extend over the next twenty years, thus renewing agreements which had already existed for some years, and which would give the Company a very strong hold indeed upon the Mediterranean system of telegraphs. They wanted the telegraph system to have, as far as possible, an international character. He found that the different countries were by degrees recognising this policy, and that, on the whole, they were very friendly towards the Company. A letter had been addressed to Sir James Anderson by a shareholder, who wrote to ask whether a telegraph conference was to be held in Paris, and whether it was likely to reduce the

PATENT
SILICIUM BRONZE AND SILICIUM COPPER WIRE.
The best for overhead Telephone and Telegraph Lines,
AND ALL ELECTRICAL PURPOSES.
Hard Drawn High Conductivity Copper Wire.
ROLLED AND DRAWN
PHOSPHOR BRONZE.

PHOSPHOR BRONZE
BEARINGS, BUSHES,
AND OTHER PARTS OF
ELECTRICAL MACHINERY.
SOLE PROPRIETORS of the British, Indian and Colonial Patents,
THE PHOSPHOR BRONZE COMPANY (Limited),
87, Sumner Street, Southwark, London, S.E.
WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

Digitized by Google

Company's tariffs, and consequently interfere with their dividends. In reply to that he had to state that a conference would be held in Paris, as it was held in Berlin five years ago; but their position was so strong, and they were so useful to all nations, that he could not see how they would interfere with, or do any serious harm to, the Company. There was not a Power in Europe whose land telegraph system was returning a profit, and it would be very hard for the conference to reduce the rates of the Company in any unfair way, simply because they could reduce their own rates as they pleased out of the public money. Whatever concessions they might make he believed they would be in such a direction that they would produce an increased traffic, by which their revenues would not lose. That was the policy they intended to pursue at the conference. They had now a little difference of opinion in regard to Egypt, whither he was proceeding in a few days, and he hoped his visit would be instrumental in settling the little misunderstanding that existed. He knew that they would be fighting with right on their side. He concluded by moving the adoption of the report and accounts.

The VICE-CHAIRMAN (the Marquis of Tweeddale) seconded the resolution, which was carried unanimously.

On the motion of the CHAIRMAN, seconded by Sir JAMES ANDERSAN, Mr. Geo. Garden Nicol was re-elected to his seat at the Board, as was also Mr. J. D. Pender.

The Auditors, Mr. Henry Dever and Messrs. Welton, Jones, and Co., were re-appointed, and the meeting closed with a vote of thanks to the Chairman and Directors.

[*We shall publish a full report of this meeting in our next issue.*]

Direct United States Cable Company (Limited).

The following is the report of the Directors for the six months ended December 31, 1889, to be presented at the twenty-fifth ordinary general meeting of the Company, to be held at Winchester House, 50, Old Broad-street, E.C., on Friday, January 17th, at two p.m.:—

2. The revenue for the half-year (still subject to revision), after deducting out-payments, amounted to £42,356. 12. 1d. against £34,188 (after similar deductions) for the corresponding period of 1888, being a difference of £8,168. 12s. 1d. in favour of the half-year under review, owing to the operation of the 1s. tariff throughout the whole of this period, as compared with tariffs of 6d. for two months, and 1s. for four months, in the corresponding period of the previous year.

3. The working and other expenses for the same period, including income-tax, but exclusive of cost of repairs of cable, amounted to £15,509. 7s. 8d., leaving a balance of £26,847. 6s. 5d. as the net profit of the half-year, making with £2,719. 2s. 11d. brought forward from the previous half-year, a total of £29,566. 9s. 4d. For the corresponding half-year of 1888 the working expenses and other payments amounted to £16,475. 6s. 9d.

4. Interim dividends of 3s. 6d. per share for the quarter ended September 30, 1889 (paid October 24, 1889), and of 3s. 6d. per share for the quarter ended December 31, 1889 (payable January 24, 1890), together amounting to £21,248. 10s., have been declared, and the balance of £8,317. 19s. 4d. on the revenue account has been carried forward.

5. An interruption of the main cable occurred on October 9th last, in the neighbourhood of the Green Bank, and was repaired on November 2nd. The cable was found to have been broken by a vessel's anchor. On November 9th, in a position near the previous break, the cable was again interrupted for the removal of a fault which interfered with efficient working. The fault was successfully cut out, and communication restored, on November 12th. The cost of these repairing operations, including spare cable used, amounting to £4,119. 14s., has been charged to the reserve fund account, as usual.

6. In the matter of the action of the Anglo-American Telegraph Company *v.* Cie. Française du Télégraphe de Paris à New York, the appeal to the Council of State mentioned in the last report is still pending.

NEW COMPANIES REGISTERED.

ARGENTINE INTER-PROVINCIAL RAILWAY COMPANY (LIMITED).—Registered by Ashurst, Morris, Crisp, and Co., 6, Old Jewry, E.C., with a capital of £1,200,000 in £100 shares. Object, to acquire, construct, complete and equip, maintain, prolong, and work railways and their appurtenances, tramways, lines of telegraph, telephones, or other means of communication in the Argentine Republic. There shall not be less than three nor more than seven directors; the first to be appointed by the subscribers to the Memorandum of Association. Qualification, £500. Remuneration, £3,500, divisible.

FOWLER, LANCASTER AND COMPANY.—This company was registered January 8th, by Pyke and Minchin, 2, Metal Exchange-buildings. Objects: To carry on the business of electrical engineers, manufacturers, and contractors in the United Kingdom or elsewhere, and to light thoroughfares and public and private buildings, adopting therefor an agreement, the particulars of which are not specified in articles, dated January 4, 1890, and made with George Vaughan Fowler and Edward William Lancaster, electrical engineers at Birmingham. Capital, £22,000, in £10 shares, of which 20 are deferred shares. Subscribers of one share each are:

Arthur Mackenzie, agent, Temple-chambers, Temple-avenue.
William Marcus Pyke, solicitor, 2, Metal Exchange-buildings.
Albert Edmund Shill, architect, 30, Dayton-grove, Peckham.
Herbert Lenty Collins, clerk, 67, Lombard-street.
Charles William Rawlinson, solicitor, 11, Lincoln's Inn-fields.
Reginald William Bonser, clerk, same address.
Charles A. Elgood, solicitor, 48, Lincoln's Inn-fields.

One vote for every five shares, but maximum number of votes not to exceed 20. First directors (two to four) to be nominated by above-named subscribers, who act *ad interim*. George Vaughan Fowler and Edward William Lancaster are to be first managing directors, with all rights and powers of directors reserved in the afore-mentioned agreement. Qualifications of directors 50 shares. Remuneration of others than managing directors £100 per annum each (chairman £150 per annum), and in addition 10 per cent. on profits after 10 per cent. dividend to be divisible. Borrowing powers are not restricted.

NEW ASBESTOS COMPANY (LIMITED).—Registered by Michael Abrahams, Sons, and Co., 8, Old Jewry, E.C., with a capital of £120,000, divided into 30,000 shares of £4 each. Object, to acquire and take over upon the terms of an agreement, dated August 20, 1889, and expressed to be made between the Société Française des Amiantes of the one part, and Wm. McDonell, as trustee for the New Asbestos Company (Limited) of the other part, or any modification that may be agreed to, the assets and good will of the business of asbestos manufacturers and merchants carried on by the said Société at Tarascon, in France and elsewhere, including certain asbestos properties situate in France and in Italy.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended January 10th amounted to £1,728.

EASTERN EXTENSION COMPANY.—This company notify that the interest on their Six per Cent. Debentures, due February 1st next, will be paid on and after that date at the Consolidated Bank, 52, Threadneedle-street, E.C.

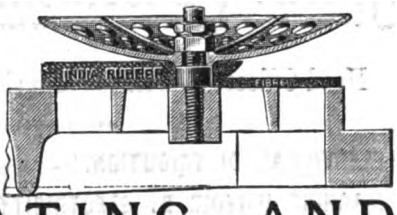
ELMORE'S PATENT COPPER DEPOSITING COMPANY (LIMITED).—Considerable business has lately been doing on the Stock Exchange in the shares of this Company. Quite recently the price of the £2 shares rose to 8⅝, but owing to rumours that the works had started and had failed, the shares fell to below 7, but have now risen to 7¼—⅜. The rumours above referred to are, we are informed, incorrect, as the works have not yet started, but are upon the point of so doing, and we feel sure that, with the assistance of the eminent electrical firm who are associated with the process, success will ensue.

NOTTING HILL ELECTRIC LIGHTING COMPANY (LIMITED).—Letters of allotment in this Company have been posted.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended January 10th, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,434.

NEW VALVE

No Rubber, Percha, or Leather.



One-half the price of Rubber or Metal.

FOR CIRCULATING AND AIR PUMPS.

Unaffected by any Lubricating Oils. Does not Expand in diameter. Feed Water may be worked at any temperature Suitable for any shaped guards. Only one quality manufactured.

"12, John-street, Sunderland, 26th Sept. 1885.

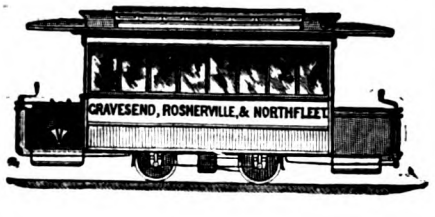
"DEAR SIRS,—In reply to your letter of the 25th inst., the Valves I got from you have done their work well, and ARE AN UNQUALIFIED SUCCESS. I will continue to get them from you as required.—Yours faithfully, JAMES WESTOLL."

For further Testimony and Prices, apply to MOSSES & MITCHELL, 68-71, Chiswell Street, London.

Digitized by Google

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Wednesday, Jan. 15, 1890.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending Jan. 15, 1890.	
					£ s. d.		Highest.	Lowest.
			TELEGRAPHS.					
£ 1,770,360	Stock	12/6	Anglo-American	52 53	5 3 9	Jan., Apr., July, Oct.	52½	...
2,614,820	Stock	25/0	Do. Preferred	87½ 88½	6 4 4	,, ,,	88½	87¼
2,614,820	Stock	...	Do. Deferred	16¾ 17¼	...	February	...	...
130,000	£10	3/0	Brazilian Submarine xd	12¼ 12¾	5 17 8	Mar., June, Oct., Dec.	12½	12¼
112,900	£100	5%	Do. 5 per Cent. Bonds	101 103	4 17 1	January and July	...	...
75,000	£100	5%	Do. Do. (2nd Series, 1906) xd	104 107	4 13 6	June and December.	...	...
16,000	10	9/0	Cuba Submarine	14½ 15	6 0 0	February and August	...	...
6,000	10	10/0	Do. Preference 10%	19½ 20½	4 19 9	,, ,,	...	...
12,931	5	2/0	Direct Spanish (£4 paid)	4 4½	4 8 11	March & September	4⅝	...
6,000	5	5/0	Do. Preference 10%	9 10	5 0 0	April and October	...	...
60,710	20	3/6	Direct United States	10 10½	6 13 4	Jan., Apr., July, Oct.	10⅝	10½
330,000	10	2/6	Eastern	13⅞ 14⅛	4 12 0	,, ,,	14¼	13⅞
70,000	10	3/0	Do. 6 per Cent. Preference	15 15½	3 17 5	,, ,,	15	...
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock	105 107	3 14 9	May and November.	106	104
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	107 110	4 10 11	February & August	...	...
250,000	10	2/6	Eastern Extension	13⅞ 14	4 12 10	Jan., Apr., July, Oct.	14⅛	13⅝
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	102 104	3 16 1	February & August	...	...
473,000	100	5%	Do. 5 per Ct. (Austrln. Gov. Sub.) Debs. 1900	102 105	4 15 3	January and July	104	...
179,177	10	2/0	Globe Telegraph and Trust	8⅝ 9	5 13 7	Jan., Apr., July, Oct.	9	8⅞
178,992	10	3/0	Do. 6 per Cent. Preference	14⅝ 14⅞	4 0 8	,, ,,	15	14⅛
150,000	10	5/0	Great Northern xd	15⅝ 16¼	4 12 4	Jan., July, and April	15⅞	...
17,000	25	12/6	Indo-European	41 43	5 16 3	April and October	...	...
9,000	8	4/0	Reuter's	7 7½	5 6 5	April and October	...	...
15,609	10	3/6	West African Telegraph xd	9½ 10½	...	...	...	...
300,000	100	5%	Do. 5 per Cent. Debentures	99 102	4 18 0	March & September	100½	...
30,000	10	5/0	West Coast of America	11¼ 11¾	4 5 1	January and July	11½	...
150,000	100	8%	Do. Debentures 8% xd	119 124	6 9 1	June and December	...	...
88,321	10	nil.	West India and Panama	2⅝ 3	...	...	3	2⅞
34,563	10	12/0	Do. 1st Preference 6%	11⅓ 12	...	April and October	11⅛	11⅜
4,669	10	10/0	Do. 6 per Cent. 2nd Preference	14½ 15½	3 17 5	...	15	...
45,181	15	6/0	Western Brazilian	9¼ 9⅝	7 13 10	May & November	9⅞	9½
$1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	118 122	5 14 9	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	100 102	5 17 2	March & September	...	...
			TELEPHONES.					
224,850	14/0	5%	Consolidated Telephone and Maintenance	1⅜ 1⅛	...	Yearly	...	...
220,000	£1	3%	Oriental (11s. paid)	⅝ ⅞	3 15 11	...	...	...
*	*	6%	National	5½ 5⅝	...	...	5⅝	5⅛
55,000	5	3/0	United River Plate	4½ 5	...	January and July	...	...
			ELECTRIC LIGHT.					
23,692	5	...	Anglo-American (fully paid)	...	...	February & August	...	...
79,934	5	6%	Swan United (£3. 10s. paid)	4⅜ 5⅛	4 0 0	...	5⅛	4⅞
500,000	10	...	Metropolitan Electric Supply (£3 paid)	4⅜ 5¼	...	...	4⅞	4⅞
			MISCELLANEOUS.					
37,350	12	12/0	Telegraph Construction and Maintenance	44 46	5 4 9	March and July	45½	45
41,600	10	10/0	India Rubber, Gutta Percha & Telegraph Works	18 19	5 5 3	February & August	18⅞	...



Before Ordering!

ELECTRICAL PLANT & ACCESSORIES

WRITE FOR THE FOLLOWING PAMPHLETS TO THE

UNITED ELECTRICAL ENGINEERING CO., Ltd.

Head Offices: 3, Princes Mansions, VICTORIA ST., WESTMINSTER.

"ELECTRICAL DISTRIBUTION."—Commercially considered, with Estimates.

"MACHINE DRIVING BY ELECTRICITY."—The Uses of Electro-Motors for Traction and Stationary Purposes.

"THE TELPHER SYSTEM OF CHEAP TRANSPORT," for Minerals, Goods and Passengers.

"ELECTRICAL SUPPLIES."—Prices and Particulars of the most approved Electrical Appliances.

ELECTRICAL PLANT ON VIEW.

Digitized by Google

THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 610.—Vol. XXIV. FRIDAY, JANUARY 24, 1890. Price Fourpence.

NOTES.

As we have previously announced, the Royal Society resolved in November last to raise a fund for establishing a memorial of an international character commemorative of the life work of Joule. This memorial it has been decided shall have for its object the encouragement of research in physical science, as well as the erection of a tablet or bust in London. It is unnecessary to insist on the world-wide importance of the discovery of the law of the conservation of energy, or to again point out the vast field covered by Joule's researches and the marvellous accuracy of his results. Electricians, we feel confident, will not be backward in contributing towards a fund to do honour to his memory.

In the suggestive Paper by Mr. Albion T. Snell on "The Distribution of Electrical Energy over Extended Areas in Mines," which will be found in another column, the employment of alternate-current motors on a commercial scale is placed, not without reason, somewhat *in futuro*. It is interesting to note in this connection that our New York correspondent reports this week that the Hercules Mining Machine Company, of Pittsburgh, have given a large order to the Westinghouse Company for Tesla motors to operate their coal-mining machines. The result of this venture will be watched with considerable interest by electrical engineers in this country, who have not up to the present been over-favourably impressed by the performances of this motor so far as they have been made public.

It will be seen also by our New York letter that the telephone companies are in many cases offering a vigorous opposition to the introduction of electric traction. This is not surprising, since an electric railway with an earth return must be a peculiarly severe trial to the somewhat delicate constitution of a telephone system.

Duplex telephony has hitherto not been actually brought into practical operation, although it has been known to be theoretically possible. The recent researches, however, of Dr. Rosebrugh, of Toronto, which we describe in another column, appear to have led him to several practical suggestions for the use of telephone lines to carry more than one message at one time. Some of these suggestions, though they increase the carrying capacity of the lines, are sesqui-plex rather than duplex. Dr, Rosebrugh has come out victorious in the interference case in the United States Patent Office, which has long been pending on this invention between himself and the electricians of the Western Union Telegraph Company.

When is the microphone interference case in the United States Patent Office to be settled? For twelve years the ball has been kept rolling between Berliner and Edison, both of whom claim priority. No doubt delay is to the interest of the rival parties, since the patent, *when issued*, will date from the day of issue. Our American cousins will have to serve a seventeen years' monopoly from that date for an invention which has already been tied up for twelve years, and which ought in five years to be free. Yet they call the States a free country!

Prof. Righi has been extending his researches on the action of ultra-violet rays in augmenting the potential of a body placed in their path. The theory is that under the influence of such radiation the gaseous particles near the body become charged negatively, and are transported along the lines of electric force. The loss of the negative electricity causes the body to have a higher positive potential, and this process of molecular convection goes on until the attraction between the negatively charged particles and the positively charged body prevents further action. The convection ceases when the electric density attains a certain maximum, for this determines the magnitude of the electric force. It follows that spheres of the same material become charged to potentials proportional to their radii, and that a plate becomes charged proportional to its distance from an earth plate placed parallel to it. These results Righi proves by careful measurements with a Mascart electrometer. The light employed was a special zinc burner rich in ultra-violet rays. The effect varies with the nature of the light, and also with the substance examined. The order of the metals is about the same as that in which a negative charge is lost under the action of ultra-violet light. The augmentation of potential is greater the higher the temperature. The effect is increased in a very marked degree by rarefying the air, probably because of the greater freedom of motion of the gaseous molecules.

Among other things the research suggests a new method of measuring the potential difference of contact of dissimilar substances, but, like every other method, it is subject to many points of criticism. Another result of Prof. Righi's experiments is a means of producing electric figures of quite a novel kind

Digitized by Google

by the action of ultra-violet rays on the surface of metals. It seems probable that under the action of these rays metals partially lose the gaseous film with which they are surrounded, although this film is not necessarily the source of the molecular convection. These experiments offer an explanation of the well-known fact that it is more difficult to insulate negative charges than positive ones

THE subject of electric figures and the differences between positive and negative electricity was prominently recalled by Prof. S. P. THOMPSON at the last meeting of the PHYSICAL SOCIETY in his Paper on "Electric Splashes." The figures shown, which were very beautiful, are produced by very simple means, and are strikingly illustrative of the differences between positive and negative charges.

AT the same meeting an exhaustive Paper on Galvanometers by Prof. AYRTON and his demonstrators, Messrs. T. MATHER and W. E. SUMPNER, was brought forward. The large number of instruments of all types at the Central Institution afford exceptional opportunities for comparison of their relative merits; and the information that has been collected there will, when published, be of great value to instrument makers and purchasers. The different points alluded to by Prof. AYRTON in describing the scope of the communication were very numerous, and the discussion of them was adjourned till February 7th, before which time we hope to publish a full abstract both of this paper and Prof. THOMPSON'S.

WE learn from the *American Journal of Science* that Messrs. TROWBRIDGE and SHELDON have been experimenting on the magnetic properties of alloys of nickel and tungsten, with the view of ascertaining whether the magnetic susceptibility of the nickel can be increased in the same way as that of steel is if alloyed with small quantities of tungsten. The results obtained show that the tungsten considerably increases the magnetic moment if the alloy is forged, while very little effect is produced if the alloy is cast. Moreover, variations in the proportions of tungsten and nickel do not seem to produce corresponding changes in the magnetic properties. Experiments of this kind are of great value, even if attended with but little success. We are quite ignorant of the reason why substances differ in magnetic permeability, in spite of the importance of the property to electrical engineers, and very possibly such investigations will lead to discoveries of the first importance to both science and practice.

AT the moment of going to press we learn that at their meeting held yesterday (Thursday) afternoon the Brighton Town Council adopted the electric light scheme, referred to in another column, by 35 votes to 3.

Cable Interruption.—The cable between Punta Rassa and Key West is at present interrupted.

Vera Cruz.—The municipality of Vera Cruz invite tenders for the electric lighting of the town.

Fareham.—Permission has been granted to the Fareham Electric Light Company to erect wires and posts in the town.

Carlisle.—At their last meeting the Town Council decided to oppose the Provisional Order of the Brush Electrical Engineering Company.

Royal Society.—Among the Papers down for reading yesterday was one by Dr. Hopkinson, on the "Physical Properties of Nickel Steel."

Cadiz.—The Corporation has signed a contract with Señor de la Viesca to light the streets of the town with 1,000 16 candle-power lamps.

North Berwick.—At the last meeting of the Town Council it was decided to support the Provisional Order of Messrs. Latimer Clark, Muirhead, and Co.

Electric Companies for 1889.—The *Investors' Guardian* for the 15th inst. gives the capital of the electrical companies formed in 1889 as £5,388,600.

Church Lighting.—The Chapel Royal, Savoy, is closed for the purpose of making the necessary arrangements for the installation of the electric light.

The Halifax-Bermuda Cable.—The Canadian Government has been informed that the cable from Bermuda to Halifax will be completed by the middle of June next.

Rochester.—The Rochester Town Council have decided not to oppose the Provisional Order of the Chatham, Rochester, and District Electric Lighting Company.

The Central London Railway.—At the last meeting of the Holborn Board of Works, it was decided not to offer any opposition to the Central London Railway scheme.

Glasgow.—The professional assistance of Mr. R. E. Crompton has been specially secured on behalf of the Corporation of Glasgow in reference to electric lighting matters.

Eastbourne.—At a special meeting of the Town Council on Wednesday, it was resolved by 16 votes to 3 to consent to the proposed Provisional Order of the Eastbourne Electric Light Company.

Interruption of Telegraphic Communication with Skye.—Telegraphic communication between the mainland and the Island of Syke has been interrupted by the breaking of the cable at Kyleakin.

Institution of Civil Engineers.—Amongst the recently elected Associate Members of the Institution of Civil Engineers, we note the names of Messrs. Albion T. Snell and A. A. Campbell Swinton.

Resignation of M. Coulon.—M. de Selves, Prefect of the Gironde, has been appointed Director of Posts and Telegraphs in the place of M. Coulon, who has been nominated to a post in the Council of State.

Gravesend.—The Parliamentary Special Committee of the Gravesend Town Council recommend the Council to take the necessary steps, at the first opportunity, to obtain a Provisional Order to supply electricity.

Oxford.—The Town Council last week, after a lengthy debate, decided to expunge from the Bill before Parliament the clauses relating to the purchase of the gas undertaking and those relating to the electric lighting.

The Electric Lighting of the Taj Mahal.—Prince Albert Victor visited, on Tuesday evening, the celebrated Taj Mahal, or mausoleum of Shahjehen and his consort at Agra, which was lighted by electricity for the occasion.

Chelmsford.—In consequence of the report of the Borough Surveyor on the danger to be apprehended from the electric light wires and posts, Major Cardew paid a visit to Chelmsford last week for the purpose of inspecting them.

Dundee.—The replies received to the circular sent out to the large gas consumers by the Electric Lighting Committee

Digitized by Google

inquiring whether these consumers would be prepared to adopt electric light, have proved very discouraging.

The Phonopore.—We hear that the Midland Railway Company instead of duplexing its London-Leicester wires in the ordinary manner as was originally intended, have decided to employ Mr. Langdon-Davies' phonopore apparatus.

Woking.—At the last meeting of the local sanitary authority it was decided to support the Provisional Order of the Electric Supply Company, but a motion that it was undesirable to erect overhead wires was subsequently unanimously agreed to.

The Van Rysselberghe System in Austria.—The authorities have decided to abandon the Van Rysselberghe system of simultaneous telegraphy and telephony on the Vienna-Brünn line, and to commence a telephone trunk line between these two towns early in the spring.

Plymouth.—The Town Council have decided to consent to the Provisional Order for which the Devon and Cornwall Electric Supply Company are applying, and to lodge objections with the Board of Trade to the Draft Provisional Order deposited by the Electric Trust Company.

Liverpool Physical Society.—At a meeting of this Society on the 20th, a Paper on Sir William Thomson's electric measuring instruments was read by Mr. C. H. Yeaman. The Paper was illustrated by diagrams, and various examples of the instruments described were exhibited on the table.

High Voltage Khotinsky Lamps.—The Société Khotinsky is now manufacturing 200-volt lamps of from 10 to 200 candle-power, and consuming 3·5 watts per candle. The filament is extremely fine, and to prevent breakage from oscillation the curls are kept in position by hooks attached to the top of the bulb.

London Tramways Company.—This company have introduced a Bill, which was considered by Mr. Campion, Examiner of Private Bills, yesterday, for the purpose of applying electricity as a motive power for their various systems of tramways, by means of wire ropes, chains, or electrical apparatus placed underground.

The Series Electric Traction Syndicate.—The Series Electric Traction Syndicate have concluded a contract to work the North-Western and Midland District Auxiliary Railway Company's line, 7¼ miles in length, by electricity. They have also contracted for the equipment of a further 15 miles of tramroads at present under construction.

National Telephone Electrical Society.—At a meeting of this Society last week, Mr. Fred Brown, of the Walsall Electrical Company, read a Paper on electric lighting. The lecture was rendered more interesting by a series of beautiful experiments. Samples of the various materials used in the practical work of electric lighting were also exhibited.

Hanover.—The lines of the Hanover Tramway Company are about to be extended by 40 kilometres. The extension will be worked by accumulator cars. The cells employed will be those of Messrs. Louis Blum and Co., of Marly, Switzerland, whose accumulators have been already employed at Hamburg. The cars also will be similar to those now running at Hamburg.

Surrey County Council.—At the last meeting of this Council the Highway Committee reported that they had instructed the clerk to dissent from the Brush Electrical Engineering Company's proposed Order for lighting Richmond. The Committee further reported that in their opinion a clause should be inserted in all electric lighting schemes providing that no overhead wires should be erected, and that underground wires should be laid. The report was agreed to.

Lectures on the Theory of Electrolysis.—A course of ten lectures by Mr. Holland Crompton on the theory of electrolysis and the nature of chemical change in solution commences today, at 4.30 p.m., at the Central Institution, Exhibition-road. In this course an account will be given of the recent development of the Clausius dissociation hypothesis of electrolysis by Arrhenius, Ostwal, and others; of Van't Hoff's extension of Avogadro's theorem to dilute solutions, and of Raoult's methods of determining the molecular weights of dissolved substances.

Westminster Vestry.—At the last meeting of this Vestry it was decided to grant consent to the applications of the Kensington and Knightsbridge Electric Lighting Company, the City of Westminster Electrical Syndicate, and Messrs. Renshaw, King, and Co. This action is taken in view of the fact that the Board of Trade granted Provisional Orders to the London Electric Supply Corporation and the Westminster Electric Supply Company, in opposition to the views of the Vestry.

Eastern Telegraph Company.—After protracted negotiations, the Eastern Telegraph Company has made a satisfactory agreement with the British and French Governments for a renewal of the lease of their special wire from London to Marseilles. The company will make a small annual saving in the cost of the wire. The company has secured the right for twenty years to land cables on the coast of France. Press rates will be introduced between France and her Eastern possessions of Cochin China, Annam, and Tonquin.

Proposed Association of Metropolitan Electric Lighting Companies.—A meeting was held last week under the presidency of Sir John Pender, at the offices of the Metropolitan Electric Supply Company, for the purpose of considering the desirability of establishing an Association of the Statutory Electric Lighting Companies within the Metropolis in order to promote the consideration of, and combined action upon, matters of general interest relating to electric lighting. Representatives of several of the leading companies were present, including Lord Crawford, Mr. Eustace Balfour, Mr. James Strick, and Mr. Browne-Martin.

Reduction in Telephone Charges.—The National Telephone Company announce to the subscribers to their Liverpool and district system that the rent for the use of telephones in that centre has been reduced from £20 to £15 per annum, and that arrangements are being rapidly completed for the establishment of telephonic communication between Liverpool and London. The same company also notify that on and after April 30th next the rate of the exchange subscription in Manchester will be reduced from £20 to £15. Subscribers whose contracts go beyond April 30th will be allowed a free extension of service equal to the difference between their contract rate and the reduced rate.

The London "Subway Railway" Bills.—The promoters of the London Central (Subway) Railway Bill have given an intimation of their intention not to proceed any further in the coming Session with their Bill which has been deposited. The promoters of the Kensington and Paddington (Subway) Railway Bill have also given notice that this Bill will not be further proceeded with. The abandonment of these two Bills—together with the North and South of London Subway Railway, and the City and North of London Subway Railway Schemes, the withdrawal of both of which has already been announced, leaves, of the five subway railway schemes originally projected by new companies, only the Central London Railway Bill to be proceeded with.

Brighton.—An important report by the Electric Lighting Committee was considered by the Town Council yesterday. Acting on the advice of Mr. Schoolbred, the Committee recommend—(1) That electric lighting works be established for the supply of electricity by the Corporation under the powers of "The Brighton Electric Lighting Order, 1883." (2) That the system of supply be the continuous current system at low pressure, combined with storage batteries. (3) That the area of supply defined in Schedule A to the Brighton Electric Lighting Order, 1883, be extended. (4) That works for the supply of electricity be forthwith established at an estimated cost of £30,000. (5) That the price to be charged for current be 6d. per unit.

Telephonic Extensions.—On Tuesday the trunk wire connecting Kidderminster with the general telephonic system of the National Telephone Company was formally opened by the Mayor of Kidderminster, who exchanged congratulations with the Mayors of Birmingham, Coventry, Derby, Burton, Wolverhampton, Walsall, Wednesbury, Bradford, and Nottingham. A congratulatory message was also sent to the Mayor of Man-

Digitized by Google

chester, and a conversation took place with the directors of the company at Edgware. It is anticipated that the wire will be carried into the city within the next month. The line has so far given very satisfactory results, direct communication *via* Birmingham having been established with Manchester, Bradford, and Leeds.

Mombassa Cable.—On the 19th inst. the Eastern and South African Telegraph Company completed the laying of a submarine cable 155 miles in length between Zanzibar and the headquarters of the Imperial British East African Company at Mombassa. So rapidly is the development of Africa proceeding that in a few years we shall probably hear of a railway and landline being constructed from Mombassa to the Lakes, which would immensely facilitate the work of explorers and the opening up of the interior to civilisation and trade. We understand that the Imperial British East African Company are about to construct landlines from Mombassa to all the small ports and native townships along the coast. When this is effected, as we have reason to believe it shortly will be, we may fairly anticipate a large augmentation of British trade, and facilities for explorers prospecting the country in such a manner as cannot fail to have a marked effect upon the future of the dark Continent.

Bradford.—An inquiry was held on Friday last before Mr. T. Codrington, M.I.C.E., inspector under the Local Government Board, and Colonel C. H. Luard, R.E., into an application by the Corporation for powers to borrow a further sum of £30,000 for the purpose of electric lighting. About £2,000 beyond the £20,000 originally authorised has been actually expended, and the £30,000, with regard to which the inquiry was held, is intended to cover that sum as well as the expenses of future extensions of the electric works. The immediate expenditure at present contemplated is only £10,000. The Town Clerk represented the Corporation, and no opposition was raised to the application. The inspector was supplied with information relating to the expenditure of the £20,000. The next point of inquiry was as to the sums of money which the Corporation had already obtained power to borrow by way of charge on the general district rate. It appeared that the Corporation might under existing powers borrow upon the rate to the extent of £2,000,000, but had at present only borrowed somewhat over £500,000. At the conclusion of the inquiry the inspector and Colonel Luard visited the electrical works.

Leeds.—A joint meeting of the Parliamentary Committee, the Electric Lighting Committee, and a sub-Highways Committee was held on Tuesday, for the purpose of considering the Provisional Orders sought by the several companies desirous of obtaining powers to light the borough by electricity. Applications for Provisional Orders have been made by the National Electric Supply Company, the Yorkshire House-to-House Electricity Company, and the Electric Installation and Maintenance Company. Alderman Spark moved as an amendment, "That the Council, as the local authority, be recommended to refuse its consent to the granting of Provisional Orders to the National Electric Supply Company, the Yorkshire House-to-House Electricity Company, and the Electric Installation and Maintenance Company within the borough of Leeds; and that the Council be recommended at the end of the six months referred to in the resolution passed on October 2nd, to instruct the Electric Lighting Committee to report upon the question of electric lighting with full information upon all improvements which have been made in supplying the light up to that time." Upon being put to the vote Alderman Spark's amendment was carried by a large majority. The Mayor has called a special meeting of the Council for Tuesday next to consider the question.

The Edinburgh Exhibition.—The Exhibition buildings are, we hear, making rapid progress. There are two principal buildings—one to contain the electrical and engineering exhibits, having a central span of 80ft. and two lateral galleries of 20ft. and 15ft. on each side, and about 800ft. long; and the other to contain the general industrial section, covering a space of about 250,000 square feet. These buildings present very handsome elevations, and already form prominent features of the district. The open weather has also facilitated the laying out of the grounds. The arc lighting has, as we have already announced, been placed in the hands of the Brush Electrical Engineering Company, and Messrs. King Brown and Co. undertake the principal portion of the incandescent system. There will be two special railway stations—North British and Caledonian—within the Exhibition grounds. As will be seen by our advertisement columns, tenders have also been invited for the working of a small electric railway. The line is intended to be not only a mere demonstration of the capabilities of electric traction, but to provide the visitors to the Exhibition with a means of getting from point to point in the grounds. The general management is in the hands of Mr. Lee Bapty, so that it may be expected that nothing will be omitted to ensure the success of the Exhibition. We hear that the available accommodation has been applied for more than three times over.

Private Bills in Parliament.—The Examiners of Private Bills have commenced their sittings, and amongst other Bills which they have had under consideration this week in which they have found compliance with the Standing Orders of Parliament, are the following:—The Central London Railway Bill (for incorporating the Central London Railway Company and for empowering them to construct underground railways or subways from Bayswater to the City, to be worked by electricity. The capital of the company is £2,500,000, and provision is made for paying interest out of capital during construction at a rate not exceeding 4 per cent.); the City of London and Southwark Subway (Clapham Extension) Bill (to empower the City of London and Southwark Subway Company to extend their authorised subway to Clapham. Power to raise additional capital not exceeding £200,000 is asked); the Strand Electric Lighting Bill and the St. Martin's-in-the-Fields Electric Lighting Bill (promoted for the purpose of authorising Messrs. A. and S. Gatti to erect and maintain electric lines and works and to supply electrical energy within the parishes of St. Paul, Covent Garden, St. Clement Danes, and St. Martin-in-the-Fields); and the City of London Electric Lighting Bill (for authorising the House-to-House Electric Light Supply Company to erect and maintain electric lines and works and to supply electrical energy within the City. The price for supplying the public lamps is, under the Bill, to be settled by agreement between the local authority and the undertakers).

The Civil and Mechanical Engineers' Society.—At the last meeting of this Society a Paper entitled "The Present Aspect of Electric Lighting in London" was read by Mr. E. C. de Segundo. The author held the fact that so many well-known commercial and professional men had connected themselves with companies as a proof that electric lighting was fairly on the way to assured success. He referred briefly to the various schemes on foot for the supply of electrical energy, but only considered two systems in any detail—that adopted by the London Electric Supply Corporation and that by the Metropolitan Electric Supply Company. He suggested, with regard to the former, that the use of engines of so large a horse-power might tell a great deal against the alleged economy of the whole system. There was also this further disadvantage: that should a bearing of the 10,000 horse engine or dynamo heat badly about 200,000 lights or their equivalent would be extinguished by the stoppage of the engine. He next spoke of the Metropolitan Electric Supply Company, and described how their supply of electrical energy was produced by a large number of small generating units distributed in groups over the area of supply. It was worthy of remark that the Metropolitan Company were building stations containing machinery of a type which involved no experimental element. He then referred briefly to the question of underground *versus* overhead mains, and after a few other remarks on matters of general interest connected with the subject, he concluded by stating that it was justifiable to assume that at present there was a "boom" in alternate-current machinery, and he would not be surprised to see supply companies adopt before long the high-tension continuous-current transformer system, inasmuch as it was probable that no great difficulty would be experienced in making the efficiency of the continuous-current transformer system compare very favourably with the mean efficiency of the alternate-current transformer system.

Digitized by Google

THE CLARK STANDARD CELL.

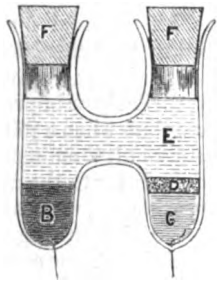
BY LORD RAYLEIGH, SEC. R.S.

In order to expedite the settlement of any open questions respecting Clark cells, I send the following remarks upon the Paper of Prof. Carhart, reprinted in *The Electrician*, p. 271, from the *Philosophical Magazine*, entitled "An Improved Standard Clark Cell with Low Temperature Coefficient."

In the first place Prof. Carhart appears to me rather to exaggerate the inconvenience arising from temperature changes in a Clark cell of ordinary construction. The coefficient is about ·00077 per degree cent., so that an uncertainty of a whole degree, affecting the E.M.F. by less than $\frac{1}{1000}$, would hardly be of practical importance. The sensitiveness to temperature is in fact only about the double of that of German silver resistance coils. In a suitable situation, and with the most ordinary care, the temperature would not be uncertain to more than one or two tenths. I have found it possible to work even closer than this in a room (next the roof), far from specially suitable, without any particular precautions; but if desired, it is easy to reduce the uncertainty under this head by some such plan as embedding the cell with a thermometer bulb in a vessel of sand.

The really serious question is whether the temperature or coefficient itself is liable to important variation without assignable cause. If it be uncertain whether the proper coefficient is ·00077, or, as in Prof. Carhart's cells, ·00039, the utility of the standard would indeed be seriously compromised.

Undoubtedly the lower coefficient would be an advantage in itself, if it could be obtained without loss in other respects. The principal feature insisted upon by Prof. Carhart is the separation of the zinc from the mercurous salt; but my experience is totally opposed to the view that the lower coefficient can thus be secured. The separation actually occurred in a large number of the cells upon which I experimented, especially in those of the H pattern,* where the mercury and mercurous salt occupied one leg, and an amalgam of zinc the other. The arrangement is shown in the figure.



H-Pattern Cell.

B, Amalgam of Zinc; C, Pure Mercury; D, Mercurous Sulphate; E, Saturated Solution of Zinc Sulphate; F, Corks. At the bottom of each leg of the cell a platinum wire sealed through the glass is shown.

That these cells have practically the same temperature coefficient as others in which the paste touches the zinc, is proved by Table XIII. of my second Paper.† I am thus at a loss to explain the low temperature-coefficient of Prof. Carhart's cells, unless indeed upon the supposition that his solutions were not throughout *saturated with zinc sulphate*. In this case the coefficient is just what might have been expected, for I found from two cells of this description the coefficient ·00038. It may be remarked that the H form is safer in this respect than those in which the zinc is at the top of the liquid, especially when removed from the paste; for the part of the liquid where saturation is of importance is that in contact with the zinc. At the top of the column the salt may easily become deficient, when the temperature rises, even though there be plenty of undissolved crystals below. The objections to unsaturated solutions are discussed in my Papers. They turn upon the difficulty of preparing a standard solution, and upon the liability to change with evaporation.

* *Phil. Trans.*, 1884.
† *Phil. Trans.*, 1885, § 40.

I quite agree with Prof. Carhart as to the importance of pure mercury. And there is undoubtedly something yet to be done in respect of the mercurous sulphate. I may remark that the sample used by me did not turn yellow when treated simply with zinc sulphate solution, but only when rubbed up also with *zinc carbonate*. In the cells made by Mr. M. Evans the paste was quite white, but this did not prevent the variation with temperature being the same as in other cases. (Table XIV., T_1, T_3).

I once came across a sample of mercurous sulphate with which it was difficult to prepare satisfactory cells. When rubbed up with zinc carbonate and zinc sulphate solution it turned dark green instead of yellow. Until the question is further elucidated I should be disposed to avoid a sample which behaved in this way.

UNDERGROUND MAINS.

BY G. L. ADDENBROOKE.

II

(*Continued from page 262.*)

Some doubt has been expressed as to the lasting qualities of lead laid in iron pipes; on this point, however, there is considerable evidence. In the Paper referred to in the first article, Mr. Fleetwood mentions that "in 1846 the Electric Telegraph Company decided to lay wires underground from their offices in the Strand to Nine Elms Station. Two lead tubes about ½in. in diameter covered with tarred yarn, each tube containing four copper wires wrapped with two layers of thick cotton, and the tube filled with a mixture of tar, resin, and grease, were drawn into a 3in. cast-iron socket pipe. The lead tubes were originally 50 yards in length. After the wires had been jointed, a pipe was drawn over the joints and soldered at each end. During the year 1887 some of this cable was recovered, when the wires were tested, and the insulation still appeared good. The tar appeared as fresh as when first put in the tube."

I have lately had an opportunity of seeing this cable, and the lead is as good as the day it was put into the iron pipe. In this instance the lead covering was protected by a wrapping of yarn, so that the lead was not in actual contact with the iron pipe, though if the yarn were damp a voltaic circuit would still be formed. To get a case where the lead is more directly in contact with the iron, we cannot do better than instance the pneumatic despatch system of the General Post Office. In this system the despatch tubes are of lead laid in iron pipes, the only thing between being the coating of Angus composition with which the iron pipes are coated, but which must be rubbed off in many places when the lead tube is drawn into the iron one. In this case no detrimental action has been traced, and the pipes appear to last perfectly when not subjected to mechanical accidents.

It may be objected here that there is no electrical current passing in the pneumatic tubes, and that, therefore, this case cannot be treated altogether as a valid argument, that no action does occur when an electric current is flowing through the lead tube, which current may leak slightly through the insulation. It, however, appears to me that the lead being in contact with the iron in many places, a metallic path for this current—when it exists—is easily open from one conductor to the other or to earth, without passing through any electrolyte, whereas from this very position, viz., the lead being in metallic contact with the iron, should damp be present, local circuits of comparatively low resistance would be set up, and in these circuits currents would flow large in quantity, though of low electromotive force, and likely to cause more action than anything due to a slight leakage of current in the mains.

There is another class of materials largely used as a protective covering for cables, viz., jute, yarn, and cotton for braids and tapes. As these are more or less perishable it is a matter of great importance to be able to form an idea of how long they are likely to last under given circumstances. When exposed to the weather in London, my experience is that however well compounded such tapes and braids may be, the outer cover-

Digitized by Google

ing will be reduced in strength in a couple of years, or perhaps less, and that in two more years there will be very little power of holding together in the material; this is the result of alternate wettings, dryings, and the action of the sun and air. Fortunately, however, materials laid under water or in iron pipes have a much longer life. I have already referred to the fact that the lead-covered cable mentioned in the extract quoted above was covered with tarred yarn. Now, this tarred yarn seems to be in almost as good condition as if it were new, and still to preserve nearly its full strength, although it was in the iron pipe buried in the ground forty-one years. It is worth mentioning also that the compounded tape covering used by the Post Office authorities to protect their gutta-percha wires underground appears to last well, having probably quite a 10 years' life on an average, though naturally a good deal depends on local circumstances. The Post Office engineers always have their gutta-percha covered wire for underground work taped and not braided. Braiding is a stronger covering, and better adapted for overhead work than tape, but for underground work it is much easier to uncoil the tape and inspect the insulation or take out faults than it would be if the wire were covered with braid, every inch of which must be cut off with a knife at some risk of damaging the insulation, while, again, the braiding cannot be replaced. I mention this as a matter of practice, though it is doubtful if the same reasoning applies with equal force to the larger cables used for electric lighting. There is another point of Post Office practice which those who are likely to have to pull several cables into the same pipe would do well to bear in mind. It is this: when the Post Office engineers want to put a new wire in a section, they do not simply draw in the extra wire, but they withdraw all the wires in the pipe, and then, adding the new wire to them, draw the whole lot back again. This may seem a cumberous, expensive, and roundabout proceeding, but it is necessary, for if the apparently easier method of drawing the extra wire in is used, the weight of the wire as it is being pulled along causes the wire to lie in a fixed course, consequently all the friction occurs in well defined places, and it is found that the new wire crossing older ones in several places, as it is certain to do, will be almost sure to chafe through the insulation of some of the older wires, or damage them so as to give rise later on to faults. As above mentioned, the Post Office use only a single tape to cover their conductors, and therefore the insulation will be more easily injured than that of electric light cables, which are usually protected by a heavy double-braid or lead-covering, so that this experience of the Post Office may rather be taken as a caution than as a prohibition. It is to obviate the risk of this chafing taking place that several systems of conduits have been devised, having a separate pipe or space for each cable, but by making the pipes or holes small, the friction when drawing cables in becomes much greater, particularly if the conduit is at all out of the straight; in this case the position of things is such as to somewhat resemble trying to pull a rope round a stationary grooved fly-wheel. The system of underground mains used by the Post Office for many years consists of 3in. socket cast-iron pipes, lead-jointed, and laid under the footpaths. The pipes open into shallow manholes at convenient distances, the manholes being made as watertight as possible, and being provided with a cover, to lie flush with the pavement, of paving stone or cement in an iron setting, which is less slippery than iron alone. These man-holes are situated on an average about seventy yards apart. Into the pipes such number of single wires as are required are drawn in together, the wires being all straight and separate and not made up in the form of a cable. When wires of a greater length are required to be drawn in than can be done at once, they are drawn through a certain distance and then coiled up; the coil is next turned over and the cable drawn through a further section, and coiled up again.

I have made a good number of inquiries to find out what is the state of the atmosphere inside these and other similar pipes used for electric lighting. However well made the joints of the pipes may be, we may take it that with a few exceptions the interior will always be damp, this damp no doubt largely arising from warm and moist air from outside entering the pipes, which as a rule will be cooler than the atmosphere. The presence of damp makes the soundness of the insulation a matter of the first importance; but as all the materials which are likely to be used in the construction of the mains stand damp well, though they may not stand alternations of damp and dryness, this, if an objection at all, is a smaller one than it might at first sight seem.

There is another system of underground mains of great originality which has been used in America with considerable success for telegraphic and telephonic purposes, and in one or two instances in this country. I allude to the Brooks system. Here the conductors are wrapped with cotton or yarn, the material not being intended so much to insulate them from each other as to keep them apart, the insulation being effected by a heavy liquid petroleum. To carry out this system, and taking as a sample the trial section which was laid some years ago between Waterloo and Nine Elms, and is still being used for part of the distance, a line of screw-jointed iron piping is laid, the wires, wrapped as above, being then drawn into it. The pipe is laid as far as possible on a slight upward or downward slope, and small screw-plugs are inserted at every highest point. At one end of the piping a reservoir is provided at some height above the highest point in the piping, and this reservoir is filled with petroleum. The petroleum is run into the pipe to fill it as far as possible, and then the screw-plugs are taken out one by one, and all included air blown off, so that the pipe becomes entirely filled with petroleum from end to end. The supply tank being kept with a quantity of petroleum in it, makes up for any leakage that may occur, which is usually slight, and the insulation of the wires is found to be high and very uniform. The actual insulation depends a good deal on the class of petroleum used, and the extent to which previous moisture has been got out of the pipe by flowing petroleum through it, and leaving it to settle afterwards. If the pipes have been well laid the loss of petroleum by leakage is very trifling, and the system has every appearance of lasting qualities, since as long as the iron pipe is not eaten through from the outside there is nothing to deteriorate. With a little modification feeders could be laid for electric lighting in this manner, which would doubtless work satisfactorily, as they would not require to be got at, at intervals, when once put down, but for mains supplying customers and requiring to be tapped at frequent and uncertain intervals the liquid insulation presents difficulties not easy to overcome.

When india-rubber cables are used for high-tension currents a good deal has been said as to difficulties in maintaining the insulation satisfactorily at the joints, although the main cable may be perfectly sound. Now, carlessly or improperly-made joints may easily give rise to trouble, but when a joint is well and properly made—and it is not at all difficult to make such a joint—its powers of resistance are but little inferior to the main cable. In this connection the following experiments, tried at Messrs. W. T. Henley and Co.'s a few weeks ago, are interesting. Messrs. Henley had a piece of 19/18 cable insulated with one coat pure rubber, one coat drab rubber, and one coat black rubber vulcanised, and one coat of proof tape, the total thickness of the insulation amounting to 60 millimetres, or rather less than $\frac{1}{16}$in. About the centre of this length of cable a piece of the insulation was cut out, leaving the bare copper. The ends of the insulation were pared down so as to leave a tapering surface, and a very small amount of rubber solution was rubbed over their surfaces, and then about five lappings of pure rubber strip were tightly wound on with the merest trace of the solution. These lappings brought up the insulation to about what it was in the rest of the cable. After the joint was made it was put in water and subjected to a pressure of 1,000 Leclanché cells, or about 1,450 volts, through a sensitive reflecting galvanometer, when no leakage whatever could be detected. At the date of the further tests, two months afterwards, this piece of cable had been alternately in and out of water all the time. Tested again in water with 1,450 volts, it appeared quite perfect. Taken out of the water it was bent so that the portion where the joint was, made a rectangular curve in this form ⌐; it was then straightened, and the process repeated four times. Tested again, no effect was observable. The cable was then taken and the jointed portion wrapped round a rod 1¼in. in diameter, four coils in all being made. This would compress the insulation in the inner side and extend that on the outer side. In this position the cable was again tested in water, but still no difference was observed on the galvanometer. Lastly,

Digitized by Google

the coil was unwrapped and the cable straightened out, and, being put in water, the 1,450 volts were again applied Even after all this ill-usage the cable and the jointed portion still showed no signs of weakness. A joint as good as this can easily and certainly be made anywhere on a system of mains, and if well protected by a stout covering of compounded tape should remain in perfect condition for an indefinite number of years. I mention these experiments not as advocating specially the use of india-rubber covered cables, but as tending to show that should other cheaper materials prove unsatisfactory, we have always this form of insulation to fall back upon.

(To be continued.)

THE ST. JAMES' AND PALL MALL ELECTRIC LIGHT COMPANY'S CENTRAL STATION.

The central station of the above company is situated in the centre of Mason's-yard, Duke-street. The boiler-room and generating-room have been dug out underneath the yard, and a three-story fire-proof building of white brick, used for stores and offices, is carried upon iron pillars and girders in the centre. The station is laid out upon the three-wire system for a total capacity of 20,000 16 candle-power lamps, which are run direct from the dynamos. A battery of accumulators, consisting of 240 cells, of Elwell-Parker's 31 L type, connected in two sets of 120, are provided on the ground floor, and will be employed to act as regulators and to supply night lights during the small hours. After going round the station, one cannot help feeling that the whole of the arrangements and apparatus in course of construction are of an intensely practical character. Every adjustment and manipulative act can be effected with ease and certainty by the attendant, while automatic gear has been fitted wherever suitable. Moreover, the designs have been executed with a view to adding further automatic gear as experience shall show to be advantageous and practicable. This system of going to work has the great advantage that the station has a good chance of keeping a clean record from the start—which the Pall Mall Company has done so far—and is, from the customer's and the shareholder's point of view, far preferable to the opposite plan of loading up the station from the outset with complicated and more or less untried automatic apparatus.

The boiler-room occupies the space nearest Duke-street. In one corner of it an artesian well is being bored, which is to reach to a depth of 380ft. The water from this will be stored in an underground reservoir of 12,000 gallons capacity, while the connection with the town supply will be retained in case of need. The boilers are of the loco type, constructed by Messrs. Davey, Paxman, and Co. They measure 20ft. 5in. in length by 6ft. diameter of barrel. The total heating surface is 1,720 square feet, with a grate area of 33½ square feet. They are constructed of mild steel for a working pressure of 170lb. per square inch. When the plant is complete there will be six of these boilers, having a total horse power of 2,400. Three Worthington pumps force the feed-water through two Berryman feed-water heaters, 22ft. high and 6ft. in diameter, in which by means of the exhaust steam the water is heated to 212° F. Injectors taking water direct from reservoir are fitted to each boiler in case of accident to the pumping system.

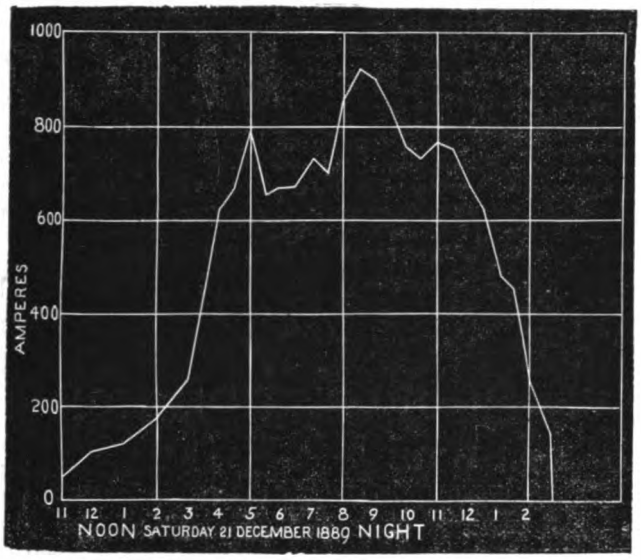
The generating-room will contain 10 Willan's central-valve engines capable of developing 210 horse-power at 350 revolutions, and two similar ones capable of developing 80 horse-power each. The engines are mounted on combination bed-plates, upon the other halves of which the field magnets and bearings of the dynamos are supported, the armatures being coupled direct to the engine shafts. The field-magnets of the dynamos are vertical, with poles downwards and supported by brass brackets from the bed-plates. The armatures are of the drum type, with the winding built up of strip and bar copper. The capacity of the 10 larger dynamos is 1,700 16 candle-power lamps each, and of the two smaller ones 700 16 candle-power lamps. They are all capable of working up to 125 volts, so that accumulators can be charged when desired. Regulation is effected by inserting resistance into the magnet circuits, which are shunts on the main. Each dynamo is provided with a switch in the shunt circuit, which is arranged so that on opening the circuit a resistance is connected across its ends through which the extra current flows, and risk of breaking through the insulation of the coils is thereby avoided. The generating sets are ranged in two rows of six each, one on either side of a central gangway, towards which all the commutators of the dynamos are directed. The main distributing and switch board will be placed at the end of the gangway distant from the boiler-house. Provision has been made against breakdown or stoppage from accident to the steam pipes by carrying them completely round the boiler-house and generating-room, and arranging stop valves and connections so that any repairs can be effected without throwing more than one boiler or two engines out of use.

The connections from the dynamos to the switch board consist of heavy insulated cables carried in porcelain insulators on brackets screwed to the overhead girders. The connection is for parallel work on a three-wire system of mains. The left-hand terminals of all the machines are connected together; the connecting cables pass first through automatic switches, which are mounted on the tops of the dynamos, and which are designed to automatically disconnect the dynamo on shutting down when the current has fallen to about 50 amperes, after leaving which they pass overhead to the switchboard, where each is connected by means of a fuse to the collecting bar. From this bar connection is made through an ammeter to the intermediate main. The other terminals of the dynamos are connected each to a gun-metal stud situated midway between two horizontal bars, to which the two outer of each of the three mains forming the feeders are connected. A gun-metal strap or bridge-piece is hinged by one end to the stud, and the other end can be clamped to either one or the other of the two bars. Thus, by shifting the strap round from one bar on to the other, any dynamo can be put on to either side of the three-wire system. As, however, this change necessitates the reversal of the polarity of the dynamo, one end of the shunt coil of the dynamo is also connected to this same stud and strap, the effect of which is that the polarity of the machine is reversed by the same operation by which it is changed over on the mains. The regulating apparatus for the shunt circuits of the dynamos is mounted at the foot of the main switchboard. A commutator switch of twelve sections, between each of which a resistance coil is connected, is mounted so that a rocking handle which carries the movable contact comes directly under the line of connections belonging to the dynamo which the switch regulates. On either side of a fixed spindle, upon which all the rocking handles are pivoted in line, runs a shaft, parallel with the fixed spindle. Each shaft is fitted with a pinion sliding on a feather, so that it can be slipped into or out of gear with spur wheels which are connected to the rocking handles. When a dynamo is coupled into circuit, both the pinions are thrown out of gear, and the rocking handle adjusted until the dynamo is doing its proper share of the work. When this is the case, one or other of the pinions is thrown into gear with the spur wheel, depending, of course, upon which side of the system the dynamo is connected to. Being thus adjusted relatively to the other dynamos, the rocking handle is moved—in common with the others which are already in gear—by a 15in. handwheel, with which both shafts are fitted. The other ends of the shafts are left to be fitted with automatic gearing.

The system of underground mains adopted by the St. James' and Pall Mall Company has on one or two occasions been severely criticised, but the company's engineer, Mr. Dobson, to whose courtesy we are indebted for these particulars, is confident that the precautions taken to avoid flooding or the accumulation of water or gas in the culverts are sufficient to guard against all difficulty from that cause. In support of his view that the system of bare conductors in iron culverts is good and practical, he has the fact that they have been in use in connection with the Pall Mall Station since April 4, 1889. Also in Berlin, where there has been plenty of experience with armoured cables, the air-insulated culvert system is being adopted.

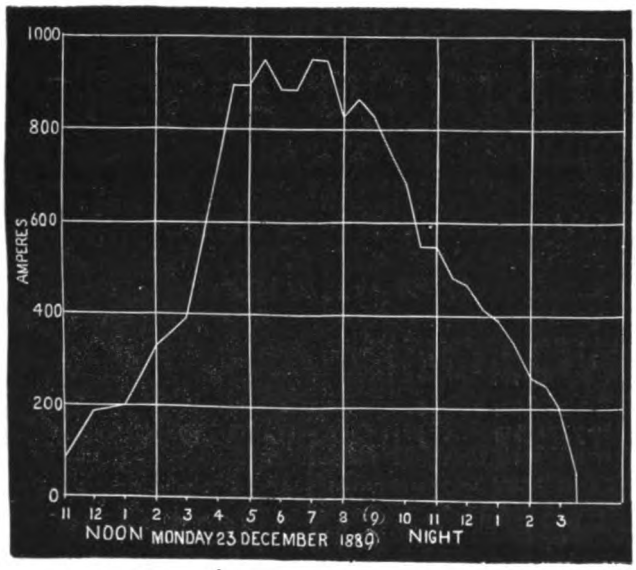
Digitized by Google

The largest main consists of eight strips of copper, 2in. wide by 0·1in. thick, or 1·6 square inch section; the two outside mains are of this size, while the middle one has a section of 0·8 square inch. The strips are supported on porcelain insulators, and spaced by means of porcelain jockeys, the whole being carried in a cast-iron culvert, the joints of which are leaded and the covers bolted on with a yarn and red-lead joint. Junction boxes are formed at frequent intervals; they are built of brick, with cast-iron frame covers and stone centres.



St. James' Station—Load Diagram No. 1.

The culverts, wherever possible, are laid with a fall towards the junction boxes, and each junction box is drained into a gully running into the main sewer. Wherever a dip occurs which cannot be drained direct a syphon-box and hydrant is fitted, so that any water which may collect can be pumped out in the same way as is done with gas mains. The mains are coupled up with fuses in the junction boxes, so that by simply bridging a fuse with a flexible cable and clips while it is removed, and then snapping off the clips, a line main can be

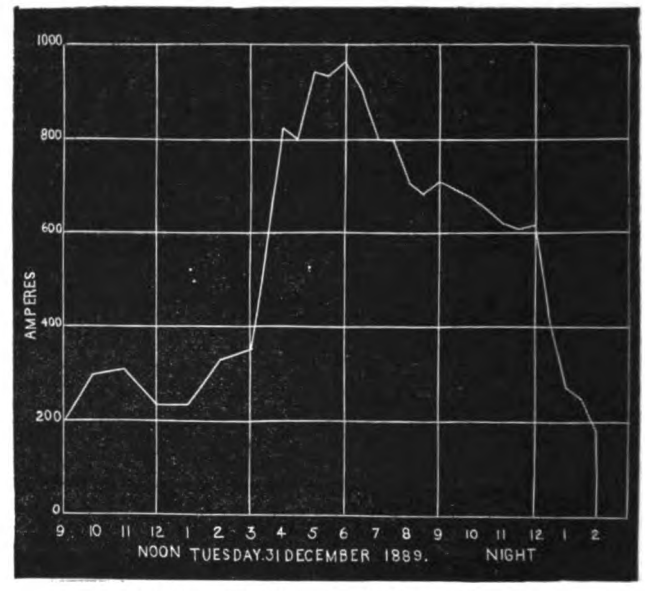


St. James' Station—Load Diagram No. 2.

disconnected for testing purposes. The service wires are of best vulcanised cable, led through gas piping which is brought through the bottom of the culvert, and secured with two back nuts. All connections to the strip mains are soldered.

The distributing system consists of a complete ring main running round Piccadilly, Regent-street, Waterloo-place, Pall Mall, and St. James'-street. This is fed by six heavy feeders, and radial distributing mains run out beyond the ring. From each feeding point on the ring pilot wires are run back to the station, so that the pressure at each point can be ascertained. The pressure on the ring main is kept constant at 107 volts, and houses connected to this main are supplied with 106 volt lamps. The voltage of the houses nearest to the station is 108, while those farthest from the station are reduced to 104. Thus the maximum variation is two volts, while the most important installations, which are on the ring main, are kept constant.

The company supply contractors for wiring houses to be connected with their mains, with a printed set of rules, which must be complied with, or connection with the main is refused. We omitted to mention one important use which it is intended to make of the accumulators, which is to fill up the gaps between the larger machines, so that they always work at an economical load. Among the more important installations supplied by the company are Her Majesty's Theatre, where a battery, placed in the theatre, is employed for the stage lighting, connected as a regulator across the mains—the Salisbury, Marlborough, Thatched House, Windham, Junior United Service, Arthur's, Oxford and Cambridge, Orleans, Brooks', Racing, and Corinthian Clubs; St. James' Hall, Moore and Burgess, the Egyptian Hall, Hotel Continental, Christie and Manson's, &c. The daily load curves taken at the station, some of which



St. James' Station—Load Diagram No. 3.

we reproduce, are quite of an exceptional character, the heavy demand being much longer sustained than in any others we have seen.

THE ROSEBRUGH DUPLEX TELEPHONE SYSTEM.

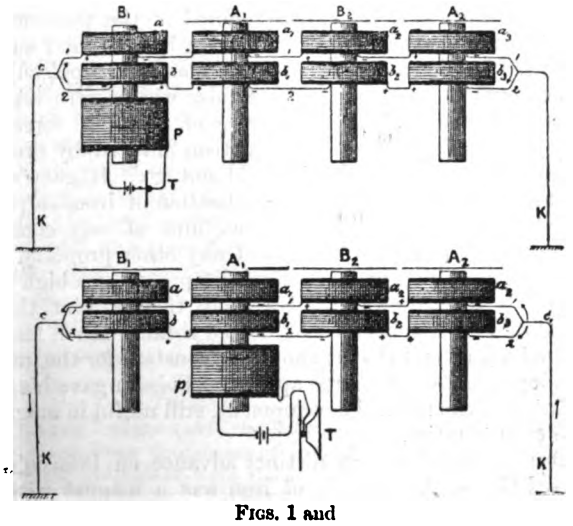
We are indebted to our esteemed contemporary the *Electrical World* of New York for the following description of a system of duplex telephony, which has recently been brought out in America by Dr. Abner M. Rosebrugh and his son, Mr. P. R. Rosebrugh, of Toronto.

In Figs. 1, 2 and 3, B_1 and A_1 are duplex or differentially-wound telephonic transmitters; B_2 and A_2 are correspondingly wound receivers. In Fig. 1, B_1 is transmitting and B_2 is receiving, and in Fig. 2 A_1 is transmitting and A_2 receiving. No. 1 and No. 2 are the two wires of the metallic circuit, and K and K are ground wires. The transmitters B_1 and A_1 are provided with a primary wire and with two secondary coils on a soft iron core, while the receivers B_2 and A_2 have two coils on a soft iron core magnetised by a permanent magnet. The coils a, a_1, a_2 and a_3, are in circuit with No. 1 wire, while the coils b, b_1, b_2, and b_3 are in circuit with No. 2 wire. The coils p and p_1 are primary coils, and are in circuit with a local battery

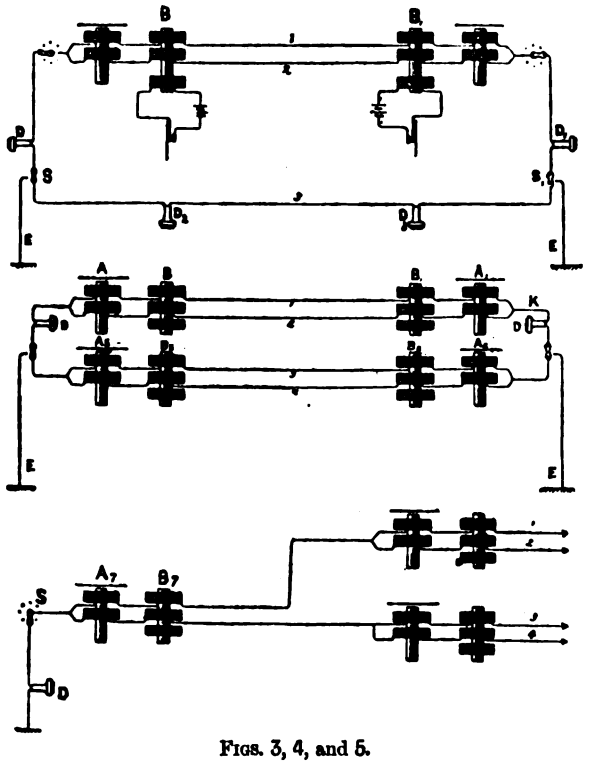
Digitized by Google

and a microphone, T. Following No. 1 wire from the point c in the direction of the arrows from left to right, it will be seen that the wire enters the coil a by the outside terminal, marked +, and makes its exit by the inside terminal, marked −. The connection is the same with a_1, a_2 and a_3, and on tracing the connection of the wire No. 2 from the point c_1 to c it will be seen that the coils b_2 and b are connected from the outside to the inside, while the coils b_3 and b_1, on the contrary, are connected from the inside to the outside.

Referring to Fig. 1, it will be seen that upon operating the microphone T the soft iron core will generate secondary currents in the coils a and b, presumably of equal strength, and as



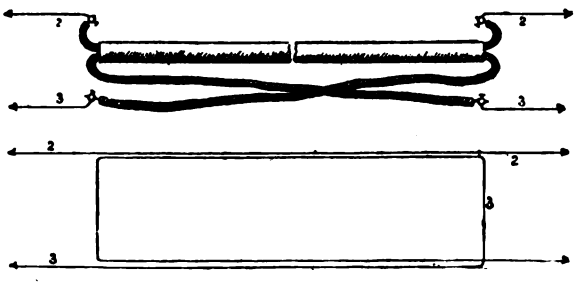
FIGS. 1 and



FIGS. 3, 4, and 5.

the outside or + wire of coil a is connected with the inside or − wire of coil b and on corresponding ends, the current from a will reinforce the current from b, and a current will be generated in the metallic circuit in the direction indicated by the arrows, the current in No. 1 wire moving in one direction and the current in No. 2 wire moving in the opposite direction. It will also be seen that from the peculiarity of the connection of the coils at A_1 and A_2 the currents in coil a_1 will neutralise the currents in b_1, and the currents in coil a_3 will neutralise the currents in b_3, whereas, on the contrary, the currents in coils a_2 and b_2 will reinforce each other; hence the receiver B_2 will respond to the transmitter B_1, while the receiver A_2 will be neutral thereto. Again, referring to Fig. 2, it will be seen that by operating the microphone T, independent secondary currents will be generated in coils a_1 and b_1, and will move toward the point c on wires 1 and 2, and in the same direction as indicated by the arrows. At the point c these currents meet, and were it not for the ground wire K they would neutralise each other; whereas, on the contrary, they reinforce each other on wire K, and proceed to "ground," and from ground to K, and to c_1, where they redivide and return to a_1 and b_1, by the wires 1 and 2. As the coils a_3 and b_3 are similarly connected and the currents traverse the two wires in the same direction, receiver A_2 will respond, and, as the coils a_1 and b_1 are similarly connected, A_1, were it a receiver, would also respond. On the contrary, as the coils of B_1 and B_2 are dissimilarly connected, these receivers will remain neutral; hence, when B_1 transmits to B_2, A_1 and A_2 are neutral, and when A_1 transmits to A_2, B_1 and B_2 are neutral. In the former case the currents traverse the two wires of the metallic circuit in opposite directions, and in the latter case the currents move on the two wires in the same direction, the circuit being completed by means of the ground or by a return wire. The same object may, of course, be attained in other similar ways.

In Fig. 3, 1 and 2 are the two wires of a metallic circuit. By means of the switches S and S_1, the two subscribers D and D_1 may either use a ground wire or a metallic circuit return wire at pleasure. In Fig. 4 the arrangement is the same as in Fig. 3, but the two wires, 3 and 4, are used as a common return wire. In Fig. 5 the branch line is also represented as being duplexed, A_7 B_7 representing duplex telephonic apparatus in the branch lines. In this latter arrangement it will be seen that with two metallic circuits three operators and a subscriber at each end of the line may communicate with each other simultaneously without interference. In this arrangement two or more wires are used as a single conductor. This increases the cross-section of the conductor and necessarily facilitates long-distance telephony.



FIGS. 6 and 7.

When telephone wires are conducted parallel to each other, particularly on long lines, they affect each other, as is well known, by induction. Various ways may be used to overcome these effects when one or both of the wires form part of a metallic circuit—as, for instance, a section of one wire may be brought within close proximity with the other, but the direction reversed. To accomplish this Messrs. Rosebrugh use a cable with two insulated wires, the terminals of which are connected, the one with wire No. 2 direct and the other with wire No. 3 reversed, as shown in Fig. 6, or the wires may be connected, as indicated in Fig. 7.

The Rubber Trade with Brazil.—A meeting of those interested in this trade was held at the London Chamber of Commerce on Tuesday to protest against the concession by the Provincial Government of Para, under which the Companhia Mercantil has power to compel all other export buyers of rubber to pay 20 reis for each kilogramme of rubber purchased by them from the receivers. A resolution approving the forwarding of a memorial to Lord Salisbury with a statement of the case was unanimously adopted According to later information this concession has been cancelled.

Digitized by Google

THE INSTITUTION OF ELECTRICAL ENGINEERS.

DR. JOHN HOPKINSON'S PRESIDENTIAL ADDRESS.

Magnetism.

(Continued from page 271.)

Prof. Tomlinson has investigated how many other properties of iron depend upon the temperature. But the most significant phenomenon is that indicated by the property of recalescence. Prof. Barrett, of Dublin, observed that if a wire of hard steel is heated to a very bright redness, and is then allowed to cool, the wire will cool down till it hardly emits any light at all, and that then it suddenly glows out quite bright again, and afterwards finally cools. This phenomenon is observed with great difficulty in the case of soft iron, and is not observed at all in the case of manganese steel. A fairly approximate numerical measurement may be made in this way: Take a block of iron or steel on which a groove is cut, and in this groove wind a coil of copper wire insulated with asbestos; cover the coil with many layers of asbestos; and finally cover the whole lump of iron or steel with asbestos again. We have now a body which will heat and cool comparatively slowly, and which will lose its heat at a rate very approximately proportional to the difference of temperature between it and the surrounding air. Heat the block to a bright redness, and take it out of the fire and observe the resistance of the copper coil as the temperature falls, due to the cooling of the block. Plot a curve in which the abscissæ are the times, and the ordinates the logarithms, of the increase of resistance of the copper coil above its resistance at the temperature of the room. If the specific heat of the iron were constant, this curve would be a straight line; if at any particular temperature latent heat were liberated, the curve would be horizontal so long as the heat was being liberated. If now a block be made of manganese steel, it is found that the curve is very nearly a straight line, showing that there is no liberation of latent heat at any temperature. If it is made of nickel steel with 25 per cent. of nickel, in its non-magnetic state, the result is the same—no sign of liberation of heat. If now the block be made of hard steel, the temperature diminishes at first; then the curve (Fig. 11) which represents the tempera-

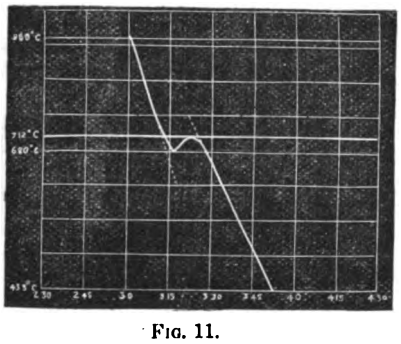


Fig. 11.

ture bends round: the temperature actually rises many degrees whilst the body is losing heat. The liberation of heat being completed, the curve finally descends as a straight line. From inspection of this curve it is apparent why hard steel exhibits a sudden accession of brightness as it yields up its heat. In the case of soft iron the temperature does not actually rise as the body loses heat, but the curve remains horizontal, or nearly horizontal, for a considerable time. This, again, shows why, although a considerable amount of heat is liberated at a temperature corresponding to the horizontal part of the curve, no marked recalescence can be obtained. From curves such as these it is easy to calculate the amount of heat which becomes latent. As the iron passes the critical point it is found to absorb about 200 times as much heat as is required to raise the temperature of the iron 1 degree centigrade. From this we get a very good idea of the importance of the phenomenon. When ice is melted and becomes water, the heat absorbed is 80 times the heat required to raise the temperature of the water 1 degree centigrade, and 160 times the heat required to raise the temperature of the ice by the same amount. The temperature of recalescence has been abundantly identified with the critical temperature of magnetism.* I am not aware that anything corresponding with recalescence has been observed in the case of nickel. Experiments have been tried, and gave a negative result, but the sample was impure; and the result may, I think, be distrusted as an indiaction of what it would be in the case of pure nickel. The most probable explanation in the case of iron, at all events, appears to be that when iron passes from the magnetic to the non-magnetic state it experiences a change of state of comparable importance with the change from the solid to the liquid state, and that a large quantity of heat is absorbed in the change. There is, then, no need to suppose chemical change; the great physical fact accompanying the absorption of heat is the disappearance of the capacity for magnetisation.

What explanations have been offered of the phenomena of magnetism? That the explanation must be molecular was early apparent. Poisson's hypothesis was that each molecule of a magnet contained two magnetic fluids, which were separated from each other under the influence of magnetic force. His theory explained the fact of magnetism induced by proximity to magnets, but beyond this it could not go. It gave no hint that there was a limit to the magnetisation of iron—a point of saturation; none of hysteresis; no hint of any connection between the magnetism of iron and any other property of the substance; no hint why magnetism disappears at a high temperature. It does, however, give more than a hint that the permeability of iron could not exceed a limit much less than its actual value, and that it should be constant for the material, and independent of the force applied. Poisson gave his theory a beautiful mathematical development, still usefnl in magnetism and in electrostatics.

Weber's theory is a very distinct advance on Poisson's. He supposed that each molecule of iron was a magnet with axes arranged at random in the body; that under the influence of magnetising force the axes of the little magnets were directed to parallelism in a greater degree as the force was greater. Weber's theory thoroughly explains the limiting value of magnetisation, since nothing more can be done than to direct all the molecular axes in the same direction. As modified by Maxwell, or with some similar modification, it gives an account of hysteresis, and of the general form of the ascending curve of magnetisation. It is also very convenient for stating some of the facts. For example, what we know regarding the effect of temperature may be expressed by saying that the magnetic moment of the molecule dimishes as the temperature rises, hence that the limiting moment of a magnet will also diminish; but that the facility with which the molecules follow the magnetising force is also increased, hence the great increase of μ for small forces, and its almost instantaneous extinction as the temperature rises. Again, in terms of Weber's theory we can state that rise of temperature enough to render iron non-magnetic will not clear it of residual magnetism. The axes of the molecules are brought to parallelism by the force which is impressed before and during the time that the magnetic property is disappearing; they remain parallel when the force ceases, though, being now non-magnetic, their effect is *nil*. When, the temperature falling, they become again magnetic, the effect of the direction of their axes is apparent. But Weber's theory does not touch the root of the matter by connecting the magnetic property with any other property of iron, nor does it give any hint as to why the moment of the molecule disappears so rapidly at a certain temperature.

* I have only recently become acquainted with the admirable work of M. Osmond on recalescence. He has examined a great variety of samples of steel, and determined the temperatures at which they give off an exceptional amount of heat. Some of his results are apparent on my own curves, though I had assumed them to be mere errors of observation. For example, referring to my Royal Society Paper, there is, in Fig. 38, a hint of a second small anomalous point a little below the larger one. And comparing Figs. 38 and 38A we see that the higher the heating the lower is the point of recalescence; both features are brought out by M. Osmond. The double recalescence observed by M. Osmond in steel with a moderate quantity of carbon I would explain provisionally by supposing this steel to be a mixture of two kinds which have different critical temperatures. Although M. Osmond's method is admirable for determining the temperature of recalescence, and whether it is a single point or multiple, it is not adapted to determine the quantity of heat liberated, as the small sample used is enclosed in a tube of considerable mass, which cools down at the same time as the sample experimented upon.

Digitized by Google

Ampère's theory may be said to be a development of Weber's: it purports to state in what the magnetism of the molecule consists. Associated with each molecule is a closed electric current in a circuit of no resistance; each such molecule, with its current, constitutes Weber's magnetic molecule, and all that it can do they can do. But the great merit of the theory—and a very great one it is—is that it brings magnetism in as a branch of electricity; it explains why a current makes a magnetisable body magnetic. It also gives, as extended by Weber, an explanation of diamagnetism. It, however, gives no hint of connecting the magnetic properties of iron with any other property. Another difficulty is this: When iron ceases to be magnetisable, we must assume that the molecular currents cease. These currents represent energy. We should therefore expect that, when iron ceased to be magnetic by rise of temperature, heat would be liberated; the reverse is the fact.

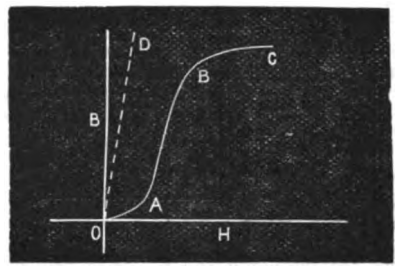
So far as I know, nothing that has ever been proposed even attempts to explain the fundamental anomally, Why do iron, nickel, and cobalt possess a property which we have found nowhere else in nature? It may be that at lower temperatures other metals would be magnetic, but of this we have at present no indication. It may be that, as has been found to be the case with the permanent gases, we only require a greater degree of cold to extend the rule to cover the exception. For the present, the magnetic properties of iron, nickel, and cobalt stand as exceptional as a breach of that continuity which we are in the habit of regarding as a well-proved law of nature.

DISCUSSION.

THURSDAY, JANUARY 9.

Sir WILLIAM THOMSON said the President had done well to emphasise the marvellous properties of iron, nickel, and cobalt, but he thought these properties were not quite so much isolated as would appear from the address. Faraday showed the continuity between paramagnetic and diamagnetic bodies, and that all substances are susceptible to magnetism when subjected to sufficiently intense magnetising forces. He had also compared the relative susceptibilities of materials, such as glass, bismuth, wood, &c.; but the absolute determination of their susceptibilities still presents a large field for interesting and valuable research. The fact that the magnetic properties of such substances could be compared was itself of immense importance, whilst Tyndall's observations on the properties of bread, Iceland spar, &c., which can be made, or are naturally anisotropic, further enhances the interest connected with the subject. The prodigious difference between the magnetic properties of iron, nickel, and cobalt, and those of other substances the speaker considered to be one of the great marvels of nature, and many ideas had been suggested by the President's address which so forcibly emphasised these great distinctions. Referring to the absence of deflection of the ballistic galvanometer when a copper core is withdrawn from a coil, he said this does not prove that no effect takes place in the copper during the process, for in reality two equal and opposite effects occur in rapid succession, thus neutralising each other's influence on the slow moving needle. In iron however, in addition to these induced currents in the metal itself, a change in the induced magnetism makes itself evident by a throw of the needle. The fact that a current or magnet when placed near iron exerts a permanent influence on the iron, whereas no such effect is produced on copper or non-magnetic bodies, always seemed to him a marvellous difference. As regards the President's remark that Poisson's theory gave no hint of hysteresis, this he thought was open to question, for the theory refers to coercive force, and this is hysteresis under another name. Coming to the subject of recalescence, Sir William said this was of immense importance, and one of the wonders duly accentuated by the President. In this connection he wished to add that most of the work on the latent heat of iron about the temperature at which recalescence occurs, had been done by the President himself. The region about the ripple in Fig. 13 requires further investigation, and if possible a cycle such as Andrews used in his experiments on evaporation and condensation should be devised. The material exists in two or more different states at the same temperature, and if the effect is reversible, then the iron should cool whilst heat is being supplied to it. In conclusion, Sir William suggested that several physical properties of the material should be tested statically whilst it was kept at temperatures little above and little below the critical one, and also during the various states in which the material exists at the same temperature.

Prof. EWING said he was glad to congratulate the Society on being favoured with such a valuable address, for he was sure that it had been no less interesting to those little acquainted with the subject, than to those familiar with recent researches. He himself was particularly interested in the matter, and was surprised that all the facts relating to magnetisation had been so clearly stated without using the word "susceptibility" or the expression "intensity of magnetisation." Commenting on the enormous amount of hysteresis exhibited by the alloy of nickel and iron (Fig. 11), Prof. Ewing said he had looked for hysteresis in similar alloys and found none; now he saw why he found none, for his experiments were made between ordinary atmospheric temperatures and 212° F., whilst Dr. Hopkinson by increasing the range of temperature had passed the critical points and shown the hysteresis to be very great. One other point he wished to mention in connection with a probable instability which exists when iron is subjected to small magnetising forces. Take the ordinary curve of magnetisation: this may be divided into three portions, O A, A B, B C (*see* Figure). The part O A had been shown by Lord Rayleigh to be a straight line, and he (the speaker) found that in a true magnetisation curve where the condition of endlessness was perfectly satisfied, the part A B should be vertical, or nearly so. His own experiments were made on rods from 300 to 400 diameters long, and on treating these mathematically as ellipsoids, he found that the magnetising force H should be measured from a line, O D, which is practically parallel to A B. A similar result had quite recently been obtained by Mr. Nagaroka, who, in some experiments on the magnetisation of nickel when subjected to mechanical stresses, had succeeded in lengthening the part O A



considerably, and then found A B to be practically vertical. In his own (Prof. Ewing's) experiments on iron he found that by tapping a rod whilst subjected to magnetising force, a permeability of 20,000 could be obtained.

The discussion was adjourned until the 23rd instant.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-night) FRIDAY, January 24th.

ROYAL INSTITUTION.

9 p.m. Lecture: "The Scientific Work of Joule." By Prof. DEWAR, F.R.S.

MONDAY, January 27th.

LONDON CHAMBER OF COMMERCE.

3:30 p.m. Meeting of the Electrical Trades Committee.

LONDON INSTITUTION.

5 p.m. Lecture, "Electrical Forces." By Prof. A. W. RÜCKER, F.R.S.

SOCIETY OF ARTS.

8 p.m. CANTOR LECTURE II. 2. "The Electro-Magnet." By Prof. S. P. THOMPSON, D.Sc.

TUESDAY, January 28th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be further discussed, "Recent Dock Extensions at Liverpool." By GEORGE F. LYSTER, M.Inst.C.E. Paper to be read (time permitting), "Bars at the Mouths of Tidal Estuaries." By W. H. WHEELER, M.Inst.C.E.

WEDNESDAY, January 29th.

INSTITUTION OF MECHANICAL ENGINEERS.

7:30 p.m. Annual General Meeting. Papers to be read (as far as time permits), "On the Compounding of Locomotives Burning Petroleum Refuse in Russia." By THOMAS URQUHART. "On the Burning of Colonial Coal in the Locomotives of the Cape Government Railways." By MICHAEL STEPHENS. "On the Mechanical Appliances Employed in the Manufacture and Storage of Oxygen." By KENNETH S. MURRAY.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Paper to be read, "The Utilisation of Blast-Furnace Slag." By GILBERT REDGRAVE.

OLD STUDENTS' ASSOCIATION.

8 p.m. Special General Meeting at the Central Institution, Exhibition-road.

THURSDAY, January 30th.

INSTITUTION OF MECHANICAL ENGINEERS.

7:30 p.m. Annual General Meeting.

Digitized by Google

The Electrician.

Published every Friday. Price Fourpence; Post Free, Fourpence Halfpenny
Editorial, Publishing and Printing Offices:

No. 1, SALISBURY COURT, FLEET STREET, LONDON, E.C.

Telephone No. 2714. Telegrams: "ELECTRICIAN NEWSPAPER, LONDON."

All Communications to be addressed to "THE ELECTRICIAN," *1, Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN."

All letters intended for insertion in "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. Subscribers should receive their copies by the first post on Friday morning.*

"THE ELECTRICIAN" *is on sale at the railway bookstalls throughout the United Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices as above.*

SPECIAL NOTICE.

Owing to the increase in the number of pages of "THE ELECTRICIAN," in order to partly cover the increased postage, we have been compelled to revise the rates for Foreign Subscriptions, which are now as follows:—

	3 months.	6 months.	12 months
For Foreign Parts and Colonies:—	s. d.	s. d.	s. d.
Within Postal Union	6 6	12 6	24 0
Aden, Borneo, Ceylon, China, India, Japan, Java, Labuan, Mozambique, New Caledonia, Persia, Philippine Islands, Siam, Transvaal, and Zanzibar	7 6	14 6	28 0
The rates for the United Kingdom remain as follows:—	5 0	10 0	19 6

TO ADVERTISERS.

"THE ELECTRICIAN" *offers exceptional advantages to Advertisers.* **It has the largest circulation of any English Electrical paper, and circulates all over the World.**

Particulars relating to Advertisements will be promptly forwarded on application to the office.

TRADE ADVERTISEMENTS *intended for the current issue must be handed in not later than First Post on Thursday morning.*

SMALL PREPAID ADVERTISEMENTS *(for Rates see page xiii.) are accepted up to 4:30 p.m. on Thursday.*

TECHNICAL PRINTING.

"THE ELECTRICIAN" PRINTING AND PUBLISHING COMPANY (LIMITED) *beg to inform Electricians, Electric Light Engineers, &c., that they make a specialty of Technical Printing, and have a Staff thoroughly acquainted with Electro-Technology. They can, therefore, promise Accuracy and Despatch in the Printing of Electrical Catalogues and Electro-Technical Literature generally.*

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.

Royal 8vo.

Early in each year is issued "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK. *The* DIRECTORY *was established in 1883, and the 1889 Edition consisted of more than 600 pages of printed matter. The names and addresses of all persons engaged in the Electrical Industries may be relied upon as accurate. Useful Tables and Electrical Formulæ, and information specially compiled for this work are given, together with popularly-written Biographical Notices of the leading Electricians, Electrical Engineers, &c., accompanied in many cases by Portraits.*

The issue for 1890, which will be still further enlarged and improved, is in active preparation, and will shortly be ready. Orders should be forwarded at once to the Publishing Office, **1,** *Salisbury-court, Fleet-street, London, E.C.*

CONTENTS OF THE CURRENT NUMBER.

NOTES	281
The Clark Standard Cell. By Lord Rayleigh, Sec. R.S. Ill.	285
Underground Mains.—II. By G. L. Addenbrooke. Continued	285
The St. James' and Pall Mall Electric Light Company's Central Station. Illustrated	287
The Rosebrugh Duplex Telephone System. Illustrated	288
The Institution of Electrical Engineers— Dr. John Hopkinson's Presidential Address.—Magnetism. Illus. Continued	290
Meetings of Scientific Societies.	291
OVERHEAD WIRES AND THE ELECTRIC LIGHT	292
Reviews	293
The Distribution of Electrical Energy over Extended Areas in Mines. By Albion T. Snell, Assoc.M.Inst.C.E. Illus.	294
American Notes	298
CORRESPONDENCE— Advances in Magnetism.—W. B. Esson	299
Transformer Devices.—C.D.S.	300
Trade Notes and Notices	300
Books Received	301
Legal Intelligence	301
COMPANIES' MEETINGS, &c.— Eastern Telegraph Company (Limited)	302
The Direct United States Cable Company (Limited)	303
New Companies Registered	305
City Notes, &c.	305
Companies' Share List	306

"THE ELECTROTECHNISCHE-ZEITSCHRIFT" OF BERLIN.

In future the above journal (with which has been incorporated "The Centralblatt für Electrotechnik") will be issued weekly instead of fortnightly, the subscription being **£1. 4s. 6d.** *per annum. Single Copies* **6d.; post free, 7½d.**

"THE ELECTRICAL WORLD" OF NEW YORK.

"THE ELECTRICAL WORLD" OF NEW YORK *can be obtained from* "THE ELECTRICIAN" *Office, Salisbury-court, Fleet-street, London, E.C. The Rate of Subscription (payable in advance), is* **£1 1s.** *per annum. Single Copies* **price 6d. each; post free, 8d.**

"THE ELECTRICIAN" PRINTING AND PUBLISHING COMPANY, Ltd., *are Agents in Great Britain for both the above well-known journals, and particulars as to Advertisements will be supplied on application to "The Publisher," 1, Salisbury Court, Fleet Street, E.C.*

OVERHEAD WIRES AND THE ELECTRIC LIGHT.

The effects of the panic in New York are beginning to be felt in this country, and we are saved the spectacle of electric lighting wires being chopped down wholesale only by reason of the fact that there are none worth mentioning to chop down. A case, however, will be within the recollection of our readers where the local authorities having arranged an electric lighting contract on the basis of overhead wires, were subsequently ready to pay 30 per cent. more per annum for the light in order to have the wires underground. This is a long way behind the example of New York, where the axemen's crusade has reduced the Empire City to semi-darkness; but it is near enough, and reports from several of our provincial towns seem to indicate that what happened at Bath will be repeated, though not perhaps in quite so satisfactory a manner for the contractors, in several provincial towns. From Weybridge we hear that there is great dissatisfaction with the overhead electric lighting wires. At Exeter the local electric lighting company is threatened with a prohibition of any further extension of its wires; and at Dundee the consent of the Police Commission for the erection of a single electric lighting wire has been positively refused. Several other places we could name are taking, or are about to take, a similar course; and at none of them can the excuse be put forward that they are so densely populated, or so crowded with traffic, as to render overhead wires, if properly erected, a public danger. The case of Glasgow is somewhat different; but even there we can hardly be expected to endorse what the Corporation has just been

Digitized by Google

induced to affirm, namely, that the 3½ miles of overhead electric lighting wires and cables in that city constitute "a serious risk to life and property."

These may be called the destructive effects of the New York panic: its obstructive effects are likely to be far more serious and widespread. Wherever there existed a local feeling against the introduction of the new illuminant, either on æsthetic grounds or by reason of the commercial jealousy of the gas proprietors, the sinister stories about fatalities due to the electric current, and the heroic remedies which had been adopted in New York to prevent them in future, have been seized with avidity, and employed as missiles to drive all electric lighting promoters off the ground. Five or six weeks ago their prospects were more hopeful than they had ever been; to-day they are clouded by a compact mass of prejudice which it will be hard to clear away, even with the powerful assistance of the Board of Trade. Happily the Board is not likely to slacken in its duty out of respect for a foolish and mistaken popular outcry. The most that the Board can concede in that direction will be to make more stringent the regulations with regard to electric light and power-conductors in general. No one can complain of this; and, indeed, the more rigorous the safeguards are made, the more quickly will public fears be dispelled. Meanwhile, it may be hoped that undertakers who have in hand Provisional Orders or Licences for electric lighting will not allow them to be snuffed out by anything less than a Parliamentary extinguisher.

At this juncture the history of the agitation which has given rise to these troubles may be studied with advantage. It should be remembered that the clamour for the removal of overhead wires in the streets of New York arose in the first instance not so much because of the dangerous currents, but rather because of the unsightliness of the wires, and their well-known insecurity. They had been hastily run up in obedience to a sudden and tremendous demand for the electric light; and being indiscriminately strung together with telephone and telegraph wires, and in the worst manner possible, they were constantly tumbling into the streets, or coming in contact with their neighbours. An outcry soon arose, and as it happened to suit the municipal and political parties then in power, an order for the removal of all wires to underground conduits was easily obtained. A Commission, called the Board of Electrical Control, was appointed to carry this decision through; and as—to quote from a New York contemporary—it consisted of "a political hack, a theatrical lawyer, and a presumptuous young attorney," its essays in the construction of underground conduits were just what might have been expected. The companies, with few exceptions, hung back from putting their property in such receptacles, and the work of the Board was threatened with being left waste and empty. Meanwhile a fresh ally was found in the trade jealousies of the rival electric companies, one of whom started, or at all events encouraged, a well got-up conspiracy to frighten the public into using none but the "harmless" current, which is that company's speciality. The press lent itself to, or was deluded by, this fiction; and in a very short space of time every accident that happened in the streets of New York was indisputably traced to the employment of high-tension and alternating currents. Some of the cases may have been genuine, and no wonder, considering the way in which the wires had been erected; but it was as senseless to attribute the fatalities to the current as it would be to attribute a boiler explosion to the steam when the boiler was known to be rotten. Nevertheless the ruse was successful, and, again to quote from a New York authority, 'the City has accomplished the feat, after four years' trial, of regulating a great industry by destroying it."

It is generally agreed on the other side of the Atlantic that electric lighting conductors of every kind must eventually be placed underground; but nobody at present seems to see how it is to be done, for none of the experiments tried so far on a considerable scale have proved wholly satisfactory. In the meantime the opinion is gaining ground that it would be comparatively easy to devise an overhead, or above-ground, system that would be unexceptionable both to eyes and nerves; and we can see no reason why such should not be allowed in many instances. As to their unsightliness they should be kept out of view as much as possible by running them over housetops, or, as in many cases would be practicable, along the sides of the buildings on suitable brackets, crossing the thoroughfares only at right angles and at suitable heights. Warned of the objections that are likely to be raised, the companies must respect, and not recklessly provoke them, as some of the telephone companies have done. The safety of the wires is a problem of still easier solution. Conscientiously done, the work need give no grounds for apprehension either from risk of fire, breakage on to the streets, or contact with human beings. The experience of the London Electric Supply Corporation is sufficient proof of this, although their system does not in all respects come up to our ideal. Only one serious accident has occurred in connection with this company's wires, and that by no means conclusively traceable to the electric current. We are rather more sanguine than our American friends about the success of the underground experiments which are now about to be tried in London; but it is evident that only in large towns can underground systems be constructed at all. In the small towns, which are just now loudest in their denunciation of the overhead system, they will have to accept that system or none; for it would never pay to put down an underground system to supply a few hundred lights. There are ways of doing the overhead work, however, that would be at once inoffensive, inexpensive, and safe; and electric lighting undertakers will be wise to take the utmost pains to conciliate public opinion on these points.

REVIEWS.

The Law Relating to Electric Lighting. By G. Spencer Bower and Walter Webb. Second Edition. (London: Sampson Low Marston, Searle, and Rivington.)

The authors of this volume, in qualifying for their task, have not confined themselves merely to a careful study of the documents which contain the law on the subject. They let the reader behind the scenes by recording and commenting upon the events which have led up to these documents, and particularly the long inquiry held by Major Marindin last year, and his report thereon. The introduction gives a general survey of these events, and also summarises the salient features of electric lighting law as it now stands, comparing the various methods under which parliamentary powers may be obtained, namely, by Licence, Provisional Order, or Special Act. The law is afterwards exhaustively dealt with in a commentary interwoven between the sections of the Act of 1882. Something has, we think, been sacrificed to the arrangement adopted. It was, perhaps, convenient in some respects to treat the sections of the Act of 1888 simultaneously with those most akin to them in the earlier Act, but owing to these sections being sprinkled about in various parts of the book without regard to serial order, it is rather difficult to find any particular section wanted. To a person who has set himself to read the book through (and it is well worth reading by anyone who desires to gain a full knowledge of the subject), this objection is of little consequence, but as a book of reference it would have been much more convenient to have printed the sections of the Act of 1888 in their proper order. An Act of Parliament may not be

Digitized by Google

very attractive reading, but if you want to know exactly what is and what is not in it, the quickest way is to read the Act through and refer to the Commentary afterwards for explanations. The Model Form of Provisional Order is printed in an appendix, together with the rules issued by the Board of Trade defining the practice on applications for licences and Provisional Orders, and the regulations issued under the Act of 1888, which principally relate to overhead wires used by persons who are not "undertakers" in terms of the Acts.

The most important parts of the Commentary fall under Sections 3, 4, 6, and 10 of the Act of 1882. It is under the first three of these that the powers of the Board of Trade mostly arise, and in pursuance whereof they have issued the rules above referred to, and have also framed the Model Order. Section 10 is described as giving the general rule as to the powers of undertakers, on which the greater part of the remainder of the Act states special limitations. The principles determining the validity of bye-laws which the local authority, with the sanction of the Board of Trade, have power to make, are fully discussed, as also under Section 17 are those which ascertain the liability of undertakers to make compensation for damage done or injury committed by them, and to injunction for causing a nuisance. The list of legal decisions collected under these headings, and the remarks thereon, will be valuable to lawyers, though perhaps of less interest to lay readers.

A useful warning is given on the subject of amendments in Bills before Parliament, which are sometimes inserted by zealous members without a clear idea as to their legal effect. In cases where the law does not allow a thing to be done which some people would like to be able to do, they will get no nearer to it by putting a clause in an Act of Parliament such as the following: "Provided always that so-and-so may not be done without the consent of the Board of Trade." If there is no power to do so-and-so, the consent of the Board of Trade will not give it, and if the power should afterwards be obtained the effect of this well-meant proviso might only be to preclude the power being exercised without the consent of the Board of Trade. Words of this kind were tacked on by amendment at the end of Section 11 of the Act of 1882, following a statement (no doubt quite an unnecessary one) of what is and was then perfectly well-settled law, namely, that Parliamentary powers and obligations cannot be got rid of by merely assigning them to others. It is pointed out that the effect of this amendment is exactly the reverse of what its framers intended.

One of the most important instances in which the Model Order has superseded impracticable provisions in the Act of 1882 is remarked upon under Section 18. That section baldly enacts that any person shall be entitled to a supply of electricity on the same terms as any other person in the same part of the undertakers' area is entitled under similar circumstances. The Model Order restricts the obligation of undertakers to lay mains and service lines at the bidding of private consumers to cases where the latter will secure payment for three years of a revenue from such new works amounting to at least 20 per cent. per annum on the outlay. It also clearly reserves to undertakers the right to make special terms with particular customers as to charges for supply, which are not to affect the ordinary charges to the public.

The authors have in a good many places made incidental reference to various technical matters. Here they have not been so happy, and in most cases have fallen into some error. For instance, it is assumed throughout that high-tension currents must necessarily involve the use of alternate-current transformers. A safety fuse would hardly satisfy the vigilance of Mr. Heaphy, if it would only operate "when a potential dangerous to life is attained"; and undertakers who supply under a storage system would be surprised to learn that they "should never place the batteries in series." The authors are shocked that electricity should ever have been treated as matter capable of cubical measurement, but they have not improved much upon this by describing it as "a force or mode of motion." These, however, are details not in any way material to the general subject, and we only call attention to them with the desire that they may be either omitted or corrected in future editions, which we have no doubt will be called for, with further alterations in the law.

THE DISTRIBUTION OF ELECTRICAL ENERGY OVER EXTENDED AREAS IN MINES.*

BY ALBION T. SNELL, ASSOC.M.INST.C.E.

Some three months ago the writer read a Paper before the Lancashire Branch of the National Association of Colliery Managers at Wigan (*Electrician*, October 25, 1889). The subject then chosen was practically the same as that under consideration now, but it was only treated in an elementary manner, and, moreover, the distribution of energy over extended areas was not discussed. The following Paper is an attempt to give a solution of the problem, in sufficiently general terms, to cover the range of work likely to occur in ordinary mining practice.† At Wigan, the writer felt that electricity as a motive power in mining operations was not properly appreciated by the majority of mining engineers. The subject was but little understood, and very vague notions existed as to the use and possible limits of electrical plant. An effort was therefore made to describe in a crude manner the application of electricity to the transmission of power, and electricity was roughly defined as a means by which energy could be transmitted from a place where it could be cheaply generated to a place where it could be usefully spent. An electrical plant was discussed in its essential details, and its component parts compared with their analogues in a compressed air system. Some plants, illustrative of every-day mining work, were described in detail, and exhaustive efficiency tests were given. The greater part of the Paper was of an elementary character.

Since then, however, the subject has received considerable attention in mining circles, and favourable expressions of opinion have been given by prominent engineers. The results obtained in pumping and hauling at St. John's Colliery, Normanton, and in numerous other pits in Great Britain, Germany, France, and America have at last been recognised as commercial successes. And it may now be fairly assumed that electricity is one of the recognised means of transmitting power in mines. The writer thus feels justified in carrying the subject a stage farther. He proposes to examine the different methods by which electricity can be applied to mining operations on a large scale. For it is evident that, if electricity is to be applied to general purposes, so as to thoroughly compete with compressed air systems, the power must be distributed in such a way that a number of motors can be supplied off the main cables. With the single exception of the dip-pumps at Andrew's House Pit (Wigan Paper), no attempt has been made in Great Britain to lay out for underground work a parallel-motor system, *i.e.*, one in which a number of suitable motors can be coupled at pleasure to the mains, without reference to each other or to the source of supply. (Since writing this Paper arrangements have been made to extend the plant at St. John's Colliery. The addition will be made with a view of a complete parallel system in the future.) This is so, not on account of any electrical difficulty, but simply from commercial considerations. The cautious conservatism of which the British as a race are justly proud has usually limited the installations to a single motor and the necessary dynamo. Hence the electrical engineers have chosen the cheapest and most suitable method of design for a single plant, viz., a series-wound dynamo and motor. This arrangement gives, in addition to simplicity, the important property of nearly constant speed of the motor, if the dynamo be kept running at a uniform rate. This elementary system of installation has done yeoman service in the past, and will still be of use for isolated plants; but the time has come when a more general solution of the problem of electrical distribution in mines is required. Fortunately, there is no need of special experimenting in this direction. The experience gained *above ground* in the supply of power by electric motors is sufficient to satisfy the most exacting conditions of *underground* work. And it is only necessary to modify the methods hitherto used to suit the new conditions.

Electrical distribution of power is accomplished in two distinct ways. The first is made by a continuous current. The second is made by alternating currents. Hitherto transmission of power has, with a few exceptions, only been accomplished commercially by continuous currents. The writer will therefore first discuss the systems involving direct currents. These methods are in general use, and may be distinguished under the following heads:—

1. *Single transmission* by series-wound dynamo and motor. Both C and E are variable.

2. *Constant current transmission*, applicable usually to one dynamo and a number of motors, all running in series with each other. C is constant and E variable.

3. *Constant potential transmission*, comprising in its simplest form one shunt or compound-wound dynamo, and a number of

* Abstract of a Paper read before the Federated Institution of Mining Engineers of Great Britain, Sheffield, January 22, 1890.

† In order to make the subject clear to mining engineers, the effects of induction and the reaction of the armature on the field magnetism are neglected.

Digitized by Google

series, shunt or compound-wound motors. E is constant and C variable.

To properly understand these methods of distribution, which are likely to obtain in the immediate future of electrical distribution of power in mines, it will be necessary to distinguish between the different types of machines, and to understand the characteristics of each system of winding.

The *series winding* is chiefly applicable to a pair of machines. It is most useful where the motor shaft is required to run at a constant speed irrespective of the load. This winding also gives the greatest possible torque or turning moment at starting. These are most important points in many cases, notably the pumping and hauling plant at St. John's Colliery (Wigan Paper), in which the motors have to start against the load of the column and the weight on the two ropes, and also have to maintain approximately the same speed whether the hauling ropes are on or not. With the series system, two or more pairs of machines may be coupled to the same work mechanically, but the electrical connections must be independent. The Normanton plant is arranged in this manner. The two dynamos are driven off the same engine, and the motors are coupled by belts to a common shaft, but each pair of machines are connected by a separate cable.

The *shunt-winding* is adapted for giving a fairly constant difference of potential or electromotive force with a varying current.* It is consequently suitable for a dynamo which has to supply a number of motors running independently of each other, with or without varying loads. If the motors are to run at fairly constant speed with varying loads on such a circuit, they must also be wound in shunt. If they are required to work with a constant torque, say, pump-driving, a series winding may be used with advantage. The "Andrews House" installation is arranged in this way. The dynamo is shunt-wound and the motors are series-wound. It is practically impossible with the shunt system to maintain a constant difference of potential at any given point—a matter oftentimes of no little importance. Every variation of load means a difference in the quantity of current flowing in the main cables; and although the dynamo may maintain practically the same electromotive force at its terminals, yet, since the number of volts lost in the cables is proportional to the current, the tension at any given point must vary directly as the current difference. And since the speed of a series-motor running with a constant torque is directly proportional to the electromotive force of supply, this variation of tension means a corresponding difference in the motor speeds. If a shunt-motor be used the speed will not vary so fast as the electromotive force, but yet the speed is roughly proportional to the tension. Thus, supposing we have a shunt-dynamo on the pit-top giving 250 volts at its terminals and supplying motors at various parts of a mine with, say, a maximum current of 100 amperes, distributed according to the work as in Fig. 5, and let the cable resistance to the first distributing centre be ·25 of an ohm, then the number of volts lost under these conditions up to this point will be = C R = 100 × ·25 = 25 0. The speed of the motors neglecting further loss in sub-mains (and other disturbing influences) will be proportional to 250 – 25 = 225 volts. Now assume that one-half the work be taken off, and the current required be only 50 amperes, the tension at the distributing box will be now—

$$\begin{aligned} E - C R &= 250 - 50 \times \cdot 25 \\ &= 250 - 12 \cdot 5 \\ &= 237 \cdot 5 \text{ volts,} \end{aligned}$$

and the speed of the motors will be roughly proportional to this figure, viz., 237·5, or, the speed will be increased in the ratio of

$$\frac{237 \cdot 5}{225} \text{ or 5 per cent. approximate.}$$

This is not a very serious alteration of speed, but in practice the motors at the extremities of the system would be affected to, say, 15 per cent., or even 20 per cent., through other losses. This shunt-winding is not adapted for motors which have to start against a very heavy load, since the torque they can exert, when run off a series dynamo, is a minimum when they are at rest. You will remember the series-winding under the same conditions gives a maximum torque. If a shunt motor be driven by a shunt dynamo the torque at starting is theoretically a maximum, *i.e.*, assuming the value of the electromotive force of supply is maintained. Practically the tension always falls when the circuit is closed, and it may be so much as to prevent the motor from starting on full load. The ideal method of winding the dynamos for a general system of distributing power is a combination of the series and shunt methods. It is called *compound-winding*. The chief advantage of this winding over the pure shunt is that the ratio of series and shunt effects can be arranged to give an approximate constant difference of potential at a point distant from the dynamo terminals, such as the distributing box in Fig. 5. A dynamo thus wound is said to be over-compounded. An approximation to this regulation can be made by using large shunt dynamos and very heavy copper mains; but, probably, for most cases of mining work, the compound-winding will be preferred, since smaller mains can be used.

* In practice, the terminal E.M.F. will vary about 10 per cent. to 15 per cent. at least between no load and full output.

Characteristic Curves of Dynamos.

The writer thinks that an explanation of the "characteristic curves" of the different types of machines referred to will be only a logical conclusion to the preceding general statements, since without some knowledge of the properties of dynamos and motors a proper appreciation of the capabilities of electrical machinery is impossible. On inspecting the curve of a series machine, it is apparent that the output of the dynamo is strictly proportional to the work required. There is no waste of energy when running light. Assume a load on the motor requiring 20 amperes, the number of volts corresponding is 275, or an output of 5,500 watts = 7·4 horse-power nearly. Now let the torque increase to 50 amperes, the volts will be 425, the watts 21,250, and the horse-power 28·5. If the load be *nil*—that is, if the circuit be opened—the amperes and volts are *nil*, and consequently the output is also *nil*. This is a most important feature in electrical transmission, and is one of the reasons why the coal consumption is always small with a well-designed plant. The series type of dynamo is only used to drive one motor, also series-wound. The chief point to note with regard to the external characteristic of a shunt-wound dynamo, running at constant speed, is the large possible variation of current for a relatively small difference in the value of the terminal electromotive force. Hence, a number of motors could be run off such a dynamo, and have their loads varied within wide limits, without largely affecting the speed of each other. It will be noticed that if the load be raised so that the work corresponds to that part of the curve which is vertical, the electromotive force rapidly falls, and if the load be maintained there is risk of the current falling away to zero. This would obtain in practice if the motors were to be overloaded. This explains why a shunt dynamo is not suited for running motors which have to start against heavy loads. (Special arrangements can be made to modify this peculiarity in some degree, such as first exciting the motor field and then closing the armature circuit through a resistance.) The external characteristic of a compound-wound dynamo shows that the electromotive force can be made practically constant throughout the limits of the designed current variation; or, it can be arranged to any desired slope. This is the type of dynamo which, in a properly modified form, the writer believes will be used for supplying power over mines in the immediate future.

Motor Mechanical Characteristics.

Motors have also their characteristics, but they are of less importance to the present subject, and they also require a better

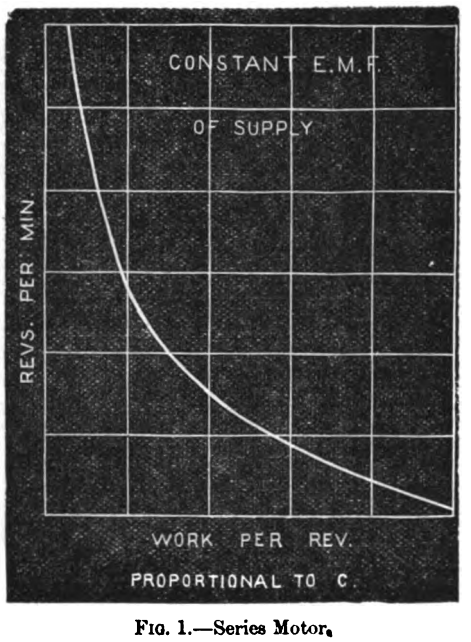


Fig. 1.—Series Motor.

acquaintance with motor work than is assumed here. Reference, however, will be made to what are called "mechanical characteristics," *i.e.*, curves showing the variation of speed for different values of torque or work per revolution.

Fig. 1 shows this relationship in a series-wound motor, supplied with current at constant electromotive force. Note that the work per revolution is a maximum for a minimum speed, *i.e.*, at starting. Fig. 2 gives the result with a shunt-wound motor.

Digitized by Google

Note that the work per revolution varies largely for relatively small differences of speed. If the load were pushed beyond the limiting value of current shown in the diagram, the curve would rapidly drop; but, assuming the potential difference to be maintained at the terminals, the motor would not stop till the current in the armature circuit were equal to the terminal volts divided by the armature resistance. The torque then would not be so great as that possible with a series winding, since the field excitation would be approximately constant through the range of the curve.

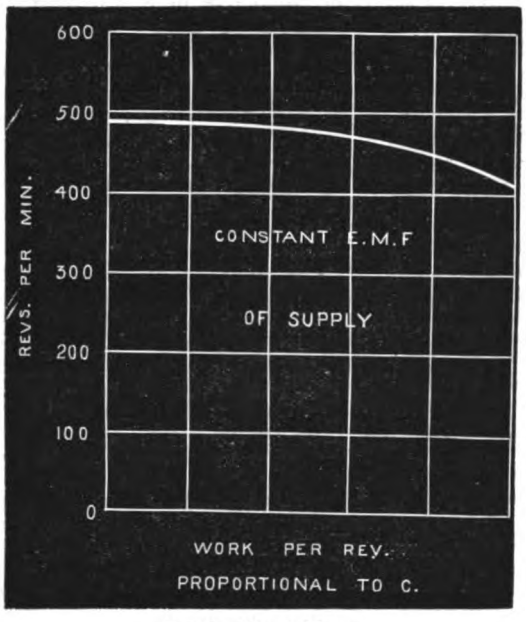


Fig. 2.—Shunt Motor

(Practically it is not possible to maintain the motor terminal electromotive force constant, owing to the fall of potential in the leads. This causes a proportionate weakening of the field as the load increases.) In the series motor both field and armature are temporarily strengthened at starting. Fig. 3 gives the same with a compound-wound motor. Note there are two ways of coupling

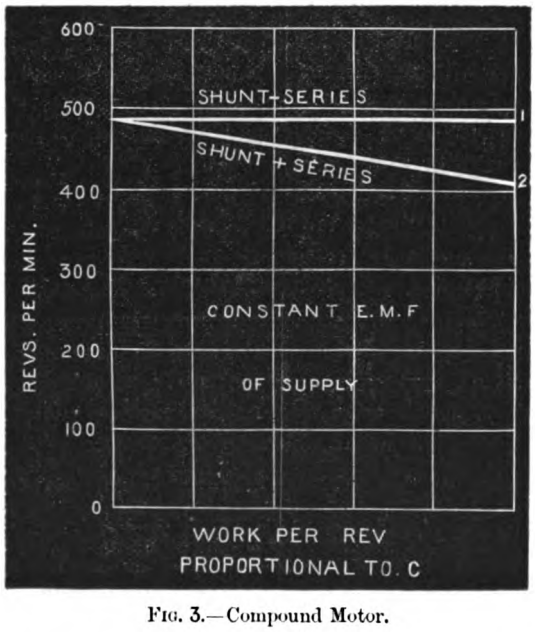


Fig. 3.—Compound Motor.

up the two field windings. In curve I. the windings are differential, *i.e.*, the series coils magnetise the field in the opposite sense to the shunt. This arrangement gives a nearly constant speed throughout the limits of the design. If the machine be overloaded, the series coil is likely to neutralise the shunt effect, and the motor will stop, and may even reverse. This type of motor is thus not adapted for starting against heavy loads, but may be used where regularity of speed is of paramount importance. Sometimes the coils are wound so as to add their effects. The result is shown in Curve II. This winding does not give such a uniform speed as the pure shunt-winding, but since the series-coil is cumulative and not differential the motor will start against a fairly heavy load, and will maintain a speed sufficiently uniform for most purposes between the limits of the design. Some care is required in starting motors of these types. In these three diagrams the abscissæ are proportional to either the current, the torque, or the work per revolution, for these quantities vary together.

Comparing the curves in Figs. 1, 2, and 3, it is evident that with a variable load the shunt and compound-windings are alone admissible, if a fairly good regulation of speed be desired. The series motor when supplied at constant electromotive force is only adapted for a constant load—say a pump or a fan—but is, *par excellence*, the machine for starting very heavy loads, as in hauling plants, with main and tail, or single ropes.

The writer has dipped thus far into the technics of electrical machinery in order to show that the question of the distribution of power by electricity over large areas in mines has been already studied, and presents no insurmountable obstacles to those responsible for the erection of such plants. It will now be convenient to examine a little more in detail the three methods of distributing energy by direct currents, and to summarise the properties of each.

I.—Series-Wound Dynamo and Motor.

Mention has already been made that this arrangement is only suitable for a pair of machines, that the motor exerts a maximum torque at starting, and maintains a nearly constant speed between the limits of the designed load if the dynamo speed be kept

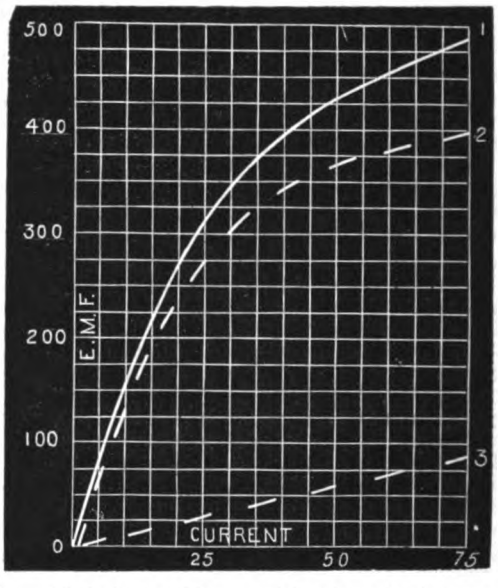


Fig. 4.—Curve 1 is the internal characteristic of a series dynamo running at a constant speed of n revolutions per minute. Curve 2 is the internal characteristic of a series motor designed to be driven by the dynamo. Curve 3 represents geometrically the summation of the resistances of dynamo, motor, and cables. Note that with series machines the field current is the same as the external current.

uniform. It is necessary to refer again to the last-mentioned peculiarity of this system, viz., the constant speed. In Fig. 4, Curve I. shows the variation of electromotive force with the current in a series dynamo running at constant speed; Curve II. shows the same relationship between the electromotive force and current in a series motor designed to be run by the series dynamo; Curve III. shows geometrically the summation of the electric resistance of the dynamo, motor, and cables. Now, Curves I. and II. have been so designed that the difference between any two corresponding ordinates is equal to the numerical value of the same ordinate in Curve III. Also the current in both machines will always be the same, for they form one continuous circuit, and Curves I. and II. were both plotted at constant speeds. Since the difference between them is equal to the electromotive force necessary to overcome the resistance of the entire circuit, it follows, if the dynamo be run at a constant speed, the motor must also run at a constant speed. There will thus be a nearly perfect regulation of the output of energy to meet the demands of the motor, and this energy will be supplied in such a manner as to keep the speed fairly constant. In practice it is not possible to obtain an absolutely constant motor speed; but the regulation can be made sufficiently near for any ordinary purposes. This system is not adapted for electric lighting, either with the lamps in parallel or in series; but a few lamps may be run with suitable precautions.

Digitized by Google

II.—Constant Current Transmission.

In this case, since the value of the current remains the same, variations of power can only be made by directly proportional variations of electromotive force. The system is applicable to any number of dynamos and motors running in series with each other, and is theoretically only limited by the safe working limits of the tension. Since high tensions (several thousand volts) are not likely to be used in mines, there will be no object in discussing this system at length. Briefly, the advantages are a capacity for transmitting energy over very extended areas, where the power is used at widely distant points, with a moderate expenditure of copper in the cables. The chief objection, other than the high tension, is the necessity for a governor of some form to each motor, and probably to the dynamo or dynamos also.

This system, however, is useful in particular cases. The writer has recently designed for Messrs. Immisch and Co. two motors to run on a constant current circuit of 10 amperes and about 2,000 volts. Each motor will develop about 10 B.H.-P. at a speed of 800 revolutions per minute, and will absorb about 1,000 volts. These machines will each run a set of three throw pumps, with 3in. rams of 9in. stroke. Each pump will raise water against a vertical head of about 750ft., making a total lift of 1,500ft., with a 4in. rising main about 1,500ft. long. The dynamo is an arc lamp machine, and will be used for lighting at night and running the motors by day. These motors are fitted with high-speed centrifugal governors which vary the value of a shunt coupled to the field terminals. The speed of the motors for a given torque is adjusted by a spring on the governor. Since the load on the pumps is practically constant, the governing device will only be used in case of accidents, such as a clack getting off its seat, or a failure of the suction. If, however, the load were to be frequently varied, the governors would keep the speed between the arranged limits. There is not much demand for constant-current motors at present, nor does the writer think they are likely to come into general use. They are chiefly adapted to arc lamp circuits, in which they run either in series with some of the lamps, or they are only run by day when lighting is not required. They may also occasionally be chosen to transmit power over very widely distant centres. The constant-current system is only suitable for lighting by lamps run in series, or in multiple series, in the main circuit.

III.—Constant Potential System of Transmission.

The features which make this system the most suitable for general distribution in mines have already been brought out when discussing the characteristics and mechanical curves of dynamos and motors. The pure shunt and the compound-dynamo have also been compared, and the general advantage of the latter shown. Before referring to a practical illustration of this system, the writer will restate the practical properties of the constant potential system with compound dynamos.

1. The dynamo, or dynamos, can be arranged to maintain a constant difference of potential at any desired centre, so as to distribute energy from this centre at the same pressure, no matter how the load may vary within the limit of design.

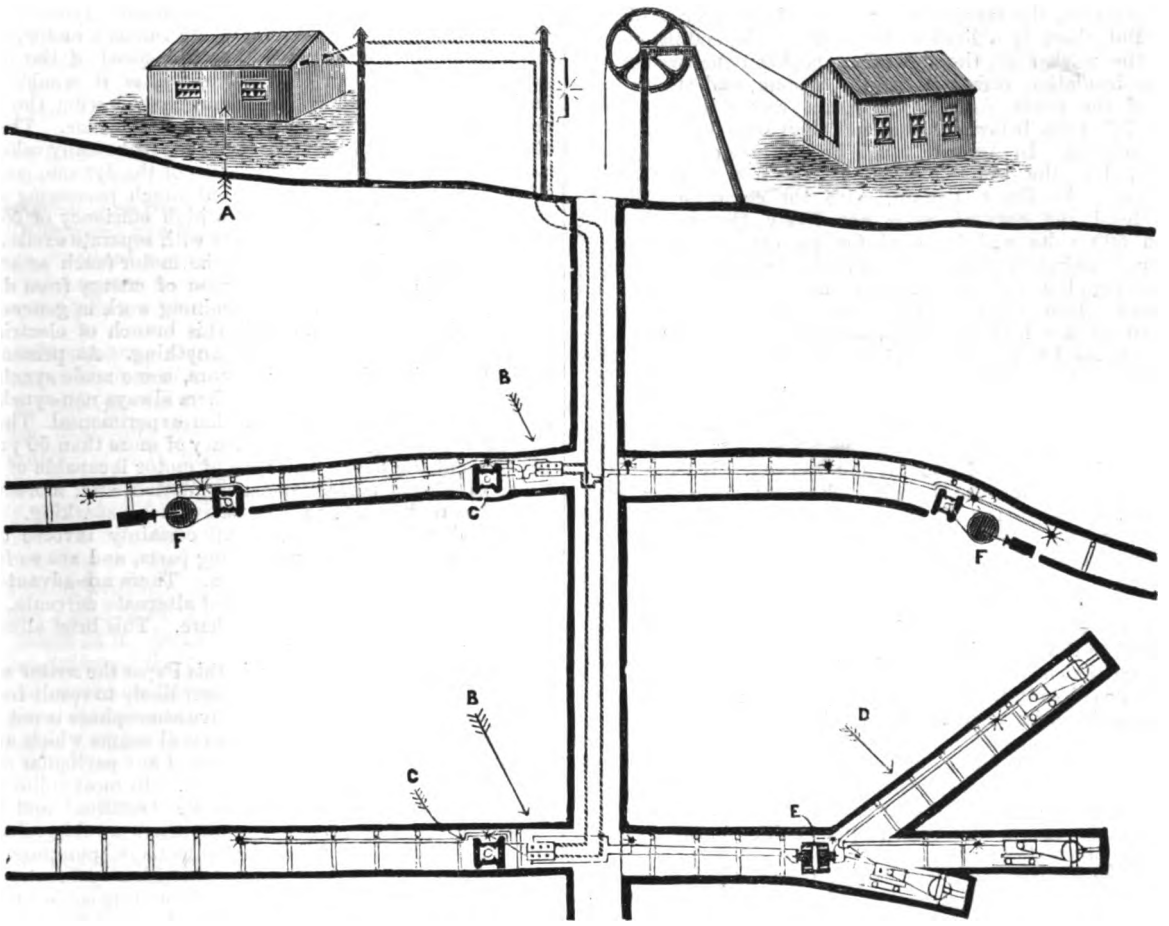


Fig. 5.—Rough Diagram showing a general application of Electrical Power to Mining Operations on the Direct-Current Parallel System, with Transformers.

A is the dynamo-house; B, B, distributing centres; C, C, hauling motors; F, F, pumping motors; E, direct-current transformer; D, rock-drills and coal-cutters. An arc lamp is shown on the pit top, and the stars indicate incandescent lamps at various points in the roads and workings.

2. Either series, shunt, or compound-motors may be used on such a circuit, so as to meet the different requirements of work.

3. A suitable unit size of dynamo being chosen to start with, the plant can at any time be increased by the addition of one or more dynamos. All of these dynamos can be coupled to the omnibus mains, and will deliver electricity in proportion to the required output; just as two or more engines can be coupled to the same shaft, or several compressors can be used to charge a common receiver and service pipe.

4. Various sizes of motors can be run on this circuit if they are wound for the same electromotive force. Thus a 50 horse-power motor can be used for hauling or pumping, a 2 horse-power motor for rock drilling, and a 10 horse-power motor for coal-cutting.

5. Power can be rapidly taken to any part of the pit by running temporary cables from the nearest distributing centre, and any of the motors can be connected. This facility for rapid work in the case of breakdowns, temporary feeders, and perhaps, with

Digitized by Google

certain precautions, sudden outbreaks of gas, will be of marked importance in the near future. Indeed, the electrical distribution of energy by the parallel system has all the flexibility of compressed air, steam, or water systems, with the farther advantage of cheapness, high efficiency, and freedom from bad breakdowns.

6. In case of accident to any part of the system, the damaged cable or machines can be easily disconnected from the mains without affecting the rest of the plant.

7. Incandescent or arc lamps can be run off the mains at any part of the circuit. The parallel system meets equally well the requirements of light or power. The importance of this will be generally admitted.

The chief drawback to the parallel system is the cost of the copper mains, if a relatively low tension of supply be selected so as to run small as well as large motors. The writer proposes the following scheme to meet this difficulty in distributing energy in mines :—

Fig. 5 is a rough diagram indicating the way in which such a general system would be applied. The details, with the exception of the cables, are sufficiently clear. Since the size of the copper for a given transmission of energy depends principally on the amount of current, the tension selected will be usually as high as possible. But there is a limit to the voltage, depending on the extent of the work area, the difference between the sizes of the motors, the insulation resistance of the system, and the general character of the roads, &c. Hitherto the writer has not used more than 725 volts below ground, and then only with separate pairs of machines. In America much higher tensions are sometimes used, but the same restrictions do not apply to the two countries. In Great Britain, with the conditions obtaining, both legal and natural, it is not likely that tensions of more than 500 volts will be used for an extended system of distribution. And even this tension will be too high for serving the motors running rock drills, coal cutters, dip pumps, and auxiliary fans. Indeed, all the larger motors near the pit bottom will be run at the higher voltage, and the smaller and more distant machines by a lower electromotive force. This lower tension will be obtained through transformers, or direct current convertors, as they are sometimes called. These will transform a small current at high pressure to a large current at low pressure. The transformer somewhat resembles a motor with two armatures. It is really a combination of a motor and dynamo. It requires no attention beyond oiling the bearings, keeping clean the commutator, &c., and adjusting the brushes. Since it has practically no strain beyond the torque of the two armatures, the wear is almost negligible in practice. These transformers could be locked up in cabins on the main in-takes. They could be inspected at regular intervals, and could be started or stopped at distributing boxes arranged at suitable spots. Transformers have not yet been used below ground to the writer's knowledge. Their utility, however, is so apparent that he expects to find them in demand before long. Their merit has already been appreciated in more than one general scheme for distribution above ground. By the proposed scheme an economy of copper could be secured in the mains, and the cost of the smaller motors would be lessened. For high tension small motors are not only expensive to wind, but also uncertain as regards insulation. The cost of the sub-mains would be practically the same in any system, because it would not be practicable to use very small or very weakly insulated leads.

The use of an uninsulated *return* is very tempting, since there is plenty of old cable lying about most collieries. The writer has in several cases used iron rope for this purpose with success. But it must be recollected that the risk of possible complications by short circuits would be increased by every additional motor. Considering all things, he does not advise the use of naked returns in cases where more than one or two motors are run off the same dynamo, particularly if the tension be high or the power large. With the system here proposed there would be little objection in most cases to using a naked return on the low-tension circuits, *i.e.*, for the returns to the transformers, assuming the high-tension mains and the dynamos and motors supplied directly from these mains were properly insulated. It is necessary to note that the cost of the transformers and their erection have to be charged against the system. This extra cost will be about £8 per horse-power per transformer. It has to be compared with the saving effected in the copper of the mains, and to the decreased cost of small motors. These two points should alone be sufficient to warrant the arrangement, without reference to the increased flexibility, and the safe use of both large and small motors. It has been proposed to drive low-tension dynamos off the shafts of large pumping motors, and utilise the current to run small motors for rock drills, &c. Immisch and Co. have already made such an arrangement for a Bohemian tin mine. This method is, however, not always applicable, and generally will not be so handy as a transformer system.

Transformers can also be used on constant-current circuits. With such a method of distributing energy the high-tension main current would probably not be used directly to drive motors in most cases, but would be converted into a lower potential current by transformers. These transformers would be placed in suitable centres for distributing power to the motors. The writer did not refer to this under the head of constant-current transmission, because he believes the high-tension current necessary in the primary circuit to be unsuited to ordinary mining practice. There are some cases where, perhaps, this system would be advantageous, but the constant-potential distribution is more likely to be adopted in the immediate future.

Alternate Current Transmission.

This Paper would be incomplete without reference to the second branch of electrical distribution of power referred to under the head of "Alternate Currents." Alternate-current dynamos have been used with great success, but there are several practical difficulties in the construction of efficient self-starting non-synchronous motors, *i.e.*, motors which are both capable of starting against a large torque without extraneous help, and which also can run at speeds bearing no simple ratio to the speeds of the dynamo. Nine years ago it was demonstrated that if two alternate-current dynamos were coupled in series with each other, and both their fields were excited by an independent direct-current dynamo, that if one machine were driven the other would run as a motor, and would do work in an efficient manner ; but the speed of the motor had to synchronise with that of the dynamo, or it would stop, and it could not be started again without first slowing the dynamo and starting the motor by some independent means. Then as soon as the two machines got into step, as it is technically called, the motor would exactly follow all the variation of the dynamo rate of rotation. Such a system of transmission, although possessing a remarkable power of self-regulation, and a high efficiency of conversion, is only adapted to a pair of machines with separate exciters, and necessitates some device for starting the motor (such as accumulators). It may pay in cases of transmission of energy from distant water-power, but is not applicable to mining work in general at present. Rapid strides are being made in this branch of electrical engineering, and it is not safe to predict anything. At present we have a few self-starting alternating motors, some made synchronous after a certain speed is reached, and others always non-synchronous. All of these, however, seem to be rather experimental. The writer does not know of one giving an efficiency of more than 50 per cent. to 60 per cent. at the best. This type of motor is capable of parallel running, of almost perfect speed regulation, and, moreover, in some forms has no brushes, so that there is no sparking. Alternating-current distribution systems will certainly involve transformers. These, however, contain no moving parts, and are so far preferable to the direct-current transformers. There are advantages and also disadvantages attending the use of alternate currents, but it would be inconvenient to discuss them here. This brief allusion must be sufficient for the present.*

In all that has been written in this Paper the writer wishes it to be distinctly understood that the danger likely to result from the use of an unprotected motor in an explosive atmosphere is not glossed over. In metalliferous mines and those coal seams which are free from gas there can, of course, be no need of any particular care in selecting the site of electrical machinery. In most collieries the "in takes" are safe enough, although the "returns" and "faces" may be dangerous. In most of such pits there would probably be little, if any, risk with fixed motors for haulage, pumping, &c., on the main "intakes." For, assuming a sudden outbreak of gas, before the main air-way could be fouled the motors could be stopped, and having once opened the switches all danger from this source would be at an end. There are pits in many parts of the country where naked lights are used in some of the roads and workings, and protected lamps in others. In these, wherever naked lights are used, electrical plant can be employed with equal safety. Speaking generally, wherever naked lights are used, electricity is not dangerous ; and in pits subject to occasional outbursts of gas it can be safely used with due caution and proper ventilation of the motor-house.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

New York, *January* 11, 1890.

The Wire Cutting in New York.—The reign of terror is at an end. Pole-cutting and wire-cutting have ceased for a time. The newspapers find full employment for their sensational powers in writing up "*la grippe*," and the public has recovered its equanimity. The local companies, it is true, have been placed

* It is open to doubt whether an alternating parallel system of distribution can possibly be so efficient as a direct-current system. Certainly, judging from our present standpoint, the plant efficiency of the alternating system will be much less, and consequently the prime cost will be more.

Digitized by Google

in a desperate position; but as an offset to that there is the fact that the time is hastening when the electrical industries of the city will be placed under worthy supervision. The Board of Electrical Control in its annual report shows that up to date the subways constructed in this city represented 73 miles of trench and 1,007 miles of duct, which will accommodate approximately 45,000 miles of telephone and telegraph, and 2,000 miles of electric light wire. At the present time there are 12,308 miles of conductors in the subways, very largely telephonic. It is further claimed that the condition of the subways is in the main satisfactory, and that they are comparatively free from moisture and gas. The report recommends that provision shall be made by which some one department, or official, shall be vested with full power over the whole subject. It is further recommended that instead of attempting to deal simply with the electrical subways, there should be a comprehensive system, including pipes for steam, gas, water, &c. The only inference to be drawn from this last recommendation is, that the subways having now been laid, the Board wishes to pull them up again; for in no other way could such a comprehensive system be arrived at. In the meantime public sentiment in favour of electrical service under proper control is steadily growing, and some of the papers are even anxious to see the restoration of the overhead system.

Standard Rules for Incandescent Wiring.—Considering the great variety of rules for incandescent wiring in this country, I am glad to note that the Council of the American Institute of Electrical Engineers has appointed a committee of members to formulate a standard wiring table. It is not intended to make any radical departure from the best practice of the day, but rather to establish a table which shall be generally recognised.

Dynamo Insurance.—Another interesting proposition, though one that has not yet taken definite shape, is the formation of a company for the insurance of dynamo electric machinery from loss by fire from any source, and especially from accidental short circuiting. It is believed that the standard insurance companies will gladly welcome the establishment of a company for this purpose, and will help it to success, while the local companies should be not less willing to patronise a corporation composed of trustworthy and responsible men, and offering a fair scheme of underwriting. There was a time when the burning out of armatures was a most ordinary occurrence. Even to-day there is far too much of it; but the improvement in construction has been so great during the last year or two, and the manufacturing companies are manifesting such marked improvement in this direction, that it seems reasonable to believe that the burnouts may now be figured down very closely, and to an average small percentage.

Electricity in China.—At the present time electricians are following with a good deal of interest the movements of two Chinese capitalists, who are now travelling about this country inspecting the different electric light systems. These Celestials represent a Chinese syndicate, which are understood to have a 90 years' contract for putting electric light apparatus in the principal cities of the empire. They have recently been the guests of Mr. Westinghouse, and it is said that they have already secured a large quantity of alternating current apparatus, the first plant of which will be set up at Canton, their headquarters. American electricians and workmen will accompany the apparatus and see to its installation and its running for a time. When interviewed on the subject a short time ago, and informed that the alternating current might occasionally kill a man, and was therefore objectionable, one of the Chinamen is reported to have said that he did not see what that had to do with the case, particularly as there was great need in China for better lighted streets, and they could easily spare a man or two as a victim to the scientific progress of the age.

Tesla Motors for Mining Purposes.—Referring to the alternating current apparatus reminds me of the fact that the Westinghouse Company has now entered the field of supplying electrical machines for mining purposes. You will remember that in my last letter I spoke of the imminent boom in this direction, and there is every prospect that the output of electrical apparatus for mining operations during 1890 will be very large. The Westinghouse Company has just secured a very large contract from the Hercules Mining Machine Company of Pittsburgh for a large quantity of generators and Tesla motors. As far as I am aware, this is the first time that alternating motors have been mentioned in connection with any such work, or with any heavy work at all. The apparatus will be used in operating the Hercules coal-mining machines, just lately brought out.

Opposition of the Telephone Companies to Electric Traction.—Owing to the remarkable mildness and openness of the winter up to the present time, electric railway work has been prosecuted briskly, not only in the Southern States, but in the Northern, and a large number of new roads are to go into operation or have just started. A notable feature of the more recent developments in this field has been the opposition displayed by the telephone companies, on the ground that the induction from the power lines has greatly interfered with the efficiency of their service, while the direct contact of a falling line with the railway circuits leads to a burning out, and involves a constant danger of fire. The electric railway men have been very much nettled by this opposition, which arises, they claim, from the idea of the telephone people that they not only own the earth, but the air too; and in more than one place the fight has been quite a hot one, involving litigation. In other places, where the telephone men have been wiser and have recognised the fact that the electric railway is a success, and is here to stay, there has been a compromise in one form or another, and in some instances the railway has borne part of the expense of changing the telephone service from a grounded to a metallic system. One of the most bitterly-contested franchises in the New England States has been that just granted at Lowell, Mass., where, after many hearings and long months waiting, the Board of Aldermen has granted permission to the local street railway company to erect poles, string wires, and use a single trolley system. The franchise is granted under various restrictive conditions as to the construction of the road and the service, and shows that even in Lowell, which has always been a centre of strong telephonic influence, the claims of the electric railway to favourable consideration as a new and important public convenience are fully recognised.

CORRESPONDENCE.

ADVANCES IN MAGNETISM.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As one having to deal frequently with the magnetic problems presented by dynamo construction, I must take exception to some of the remarks in your leader of last week. You say that "for the sake of the practical men already familiar with the law of Ohm, it is a pity that Dr. Hopkinson has not frankly used the term magnetic resistance of the circuit, but has left it in its reciprocal form as conducting power." Strange as it may appear, my impression was just the reverse of this, for I thought that one of the most praiseworthy features of the Presidential Address was the omission from it of the term magnetic resistance.

It is true that the early experimenters in groping for the relation between magnetising force and induction employed the term magnetic resistance, because, for a low induction the ratio $\frac{H}{B}$ is a constant, like $\frac{E}{C}$ for an electrical circuit. But this is not the law of the electro-magnet, and the analogy here presented is of the most superficial character. For a given electrical circuit the current is expressed as the simplest function of the E.M.F.; for a magnetic circuit, the induction is a function of the magnetising force, but of so complicated a character that its expression has hitherto defied formulæ, and graphical treatment must be resorted to. Always dangerous, analogies are only to be tolerated if they prove helpful; but here, in consequence of the fictitious colouring it gives to a particular group of phenomena, the term *resistance* constitutes an actual difficulty. To its use in a colloquial sense I raise no objection, but I think it high

Digitized by Google

time that its use in a scientific sense should disappear. In the fact that one cannot think of magnetic resistance without thinking of Ohm's law lies the objection, for with thoughts of the latter is associated a group of relations having no bearing on the case.

Freed from association with Ohm's law, *magnetic resistance* might be of service; but as such emancipation is now impossible, it had better disappear as a scientific term. Your "practical men" may be awful dullards, but it is doubtful whether their mental conceptions will be quickened by this false analogy, which might very well be included amongst the other antique notions to which reference is made.—Yours, &c.,

London, January 22, 1890. W. B. Esson.

[In spite of these objections, we think the term magnetic resistance *is* of great service in simplifying the description of the properties of the magnetic circuit. If the expression is so misleading, we fail to see how the matter is improved by using the reciprocal, as our esteemed correspondent seems to imply it is. The remark in our leader was meant chiefly to allude to the need of some term conveying the same idea as magnetic resistance.—Ed. *E.*]

TRANSFORMER DEVICES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Would it be possible, and if possible practical, to employ for the purpose of automatically opening and closing the circuit of large transformers, a small auxiliary transformer having its highest efficiency when working on open circuit? It might be arranged somewhat as follows:—A switch with mercury contacts is used, actuated by an electro-magnet in circuit with the secondaries of both transformers. When the secondary (house) circuit is opened, the switch pulled over by a spring completes the connections of the auxiliary transformer, both primary and secondary (street mains and house leads). On closing the house circuit the electro-magnet is excited by the current from auxiliary transformer through house leads and pulls over the switch, thereby opening the circuits of auxiliary transformer and closing those of main transformer. The contacts being so arranged that one set of connection is made before the other is broken, the magnet remains active, and holds over the arm of switch. The connections are rather complicated, but have been worked out in diagram, and seem practical enough—on paper.—Yours, &c., C. D. S.

Aberystwith, January 20, 1890.

[Disconnecting a large transformer from the high potential mains in the manner suggested would, we fear, destroy the insulation of the transformer whose primary circuit is suddenly broken. We suppose the auxiliary transformer mentioned is to work efficiently with light load. If it is to have its highest efficiency on "open circuit," we are afraid the method could not work.—Ed. *E.*]

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning.*]

Tenders Invited.—The Electrical and Lighting Committee of the Edinburgh International Exhibition, which will be opened in May next, invite tenders for the working of the Electric Railway within the grounds of the Exhibition. The track will be about 1,000 yards in length, and will be laid out so as to be of real utility to visitors in getting from point to point. Further particulars are given on page XIII. of our advertisements, and full information can be obtained of the Secretary, 27, Frederick-street, Edinburgh.

Messrs. Crompton and Co. (Limited).—We have received from this company an advance copy of a handsomely-bound catalogue of their well-known manufactures. The book is admirably illustrated, and gives complete descriptions, price lists, &c., of the widely used Crompton dynamos, arc lamps, projectors, parabolic reflectors, incandescent lamp fittings, both plain and ornamental, ornamental brackets, suspenders, and other artistic fittings. Towards the end of the book are given descriptions of the Crompton measuring instruments and illustrated descriptions of main switch-boards for central station work. A section of the book is devoted to electrical traction and to particulars of the Crompton-Howell accumulators. A very useful feature in the book is a set of specimen estimates for arc lighting plant for ship, factory, town, and private lighting. The catalogue is priced at 10s. 6d., but Messrs. Crompton and Co. inform us that they are issuing a catalogue containing the same text without the special illustrations, and bound in a cheaper style, price half-a-crown. This cheaper edition can be obtained, free of charge by the trade, on application to Messrs. Crompton and Co., who include in "the trade" not only electric light engineers, but all kindred trades and professions, such as architects, civil engineers, builders, merchants, and exporters. The catalogue is not devoted to the description of small electric apparatus, but mainly consists of particulars relating to heavy machinery and principal parts for central stations and large installations.

Messrs. Davey, Paxman, and Co.—About eighteen months ago we mentioned that the great increase in their business had rendered it necessary for Messrs. Davey, Paxman, and Co. to enlarge their works, and that new premises were erected to take the place of the old pattern shop, which was then cleared and added as an extension of the foundry. Increased business is responsible for a still further extension of the works. The present large addition is to the foundry and boiler shops. The good name which Messrs. Davey, Paxman, and Co. have won for themselves by the excellence and good performance of their well-known engines, and the honours and awards taken by them at the various exhibitions held during the last few years (and more especially those gained at the Newcastle and Society of Arts Trials), together with the selection of their engines for doing a large part of the driving at the Paris Exhibition, has no doubt contributed much towards making the present large extension of their works necessary.

Messrs. Felten and Guilleaume.—During the past year the firm of Messrs. Felten and Guilleaume, of Mulheim-on-Rhine, have been actively engaged in the manufacture of iron, steel, bronze, telegraph and telephone wire, and cables for telegraphic, telephonic, and electric light purposes. It is interesting to learn that, after an interval of several years, they have added a new and important link to the network of underground telegraph cables, which renders the German telegraphic system so remarkably safe in the severest storms. During the almost unprecedented snow storm of February 9, 1889, the telegraphic business of Germany was not interfered with in the slightest degree, although in the surrounding countries the telegraphic lines were broken down. The new line is from Karlsruhe to Stuttgart, 50 miles in length, formed of a 7-core cable, the cores being insulated with gutta-percha. This line was finished on November 27th last. The same year has witnessed the opening of the Buenos Ayres-Monte Video telegraphic and telephonic line, which presents many features of interest, mainly on account of a submarine section of 28 miles in length, on either side of which are aerial bronze lines of 70 and 97 miles respectively. This line is constructed on the metallic circuit system, and is used for telegraphy and telephony simultaneously, was opened on October 20th last, and works admirably both with regard to clearness and fulness of sound. No similar line is, as far as we are aware, in existence. It may be further mentioned that Messrs. Felten and Guilleaume have been very busy in manufacturing telephone cables for the German and Foreign Telegraphic Administrations; and although the resources of the firm are very considerable, they have been occupied to the utmost of their power. The same may be stated with regard to electric light cables, which are principally of Messrs. Felten and Guilleaume's impregnated fibre lead-covered type. These cables have worked very satisfactorily in the central lighting stations of Barmen, Hamburg, Bremen, and Lübeck. Owing to the large increase of business, this firm have largely increased their plant for the manufacture of bronze telegraph and telephone wire during the year, and are now producing several new types. Several inter-urban telephone lines in Germany, Austria, Hungary, Sweden, and other countries have been constructed with their bronze wire.

Messrs. C. A. Parsons and Co., Heaton Works, Newcastle.—The new works of this firm, which are conveniently situated near the Heaton station of the North-Eastern Railway, in a suburb of Newcastle-on-Tyne, are now in full operation. They cover more than two acres of ground, and are connected to the railway by a siding to facilitate the delivery and departure of heavy goods. The firm are busy with the manufacture of slow-speed dynamos of several types, in addition to other specialities. They have in hand an extensive order for the Italian Government for a number of large projectors and automatic lamps of improved design for coast defence, and also some large contracts for material for the Newcastle and District Electric Lighting Company. Messrs. Parsons and Co. are now in a position to undertake contracts of any magnitude, and will, we feel sure, have no reason to complain of want of business. The works have been specially built to meet the large demand which exists for high-class electrical machinery.

Digitized by Google

WOODHOUSE AND RAWSON UNITED (LIMITED).—This Company, as is well known, has taken over the business of Woodhouse and Rawson (Limited), the Woodhouse and Rawson Manufacturing Company, and the Woodhouse and Rawson Supply Company, together with other businesses at Manchester and Bradford, and has only been in existence six months. As regards its manufacturing business, we understand the extension has been steady and satisfactory. Mr. Charles Baker, whose business was taken over by this company, being in charge. The old specialities of the firm have been further improved, and the total number produced have been largely in advance of previous years, the turn-out of one size of switch alone being over 1,500 per week. In addition, several specialities have been worked out and acquired, chief among these being a new insulating substance which is just being put upon the market, Scott's electric flashing lantern for signalling purposes, and a new oil filter and sight feed lubricator. Important improvements are, we understand, also being made in incandescent lamps. In the supply department the extension of business has been rapid, and more recently large quantities of goods have been supplied to electrical companies abroad. In common with most electric firms the contract department of Messrs. Woodhouse and Rawson United (Limited) has been very busy, principally on electric lighting work. Police alarms systems, bells, telephones, and plating work have also added their quota to the year's industry. Among the most important lighting contracts carried out are the palace of the Maharajah of Mysore, Lord Ripon's house, &c. This department also executes a considerable amount of maintenance work, including the installations at Drapers' Hall, Exeter Asylum, &c. Contracts for the supply of instruments have been filled with the London and North Western Railway, Caledonian Railway, Manchester, Sheffield and Lincolnshire Railway, National Telephone Company, as well as the Admiralty and other Government departments. The engineering departments have been very busy, especially in the screw-making section, and a large amount of new plant has been laid down to enable the orders in hand to be executed. By the acquisition of the Bradford business, where installation work is very brisk (the company being specially appointed as contractors to the Corporation), the sphere of the company's operations has been considerably extended in the North of England. In the early part of the year the company identified themselves with the Elmore depositing process, a full description of which has appeared in *The Electrician*. Careful experiments were made by the company's electrician which convinced them of the commercial value of the invention. An English company has been formed, and is now commencing work, and the undertaking bids fair to be a decided success. If the process proves to be all that it claims it cannot fail to be one of the most important commercial undertakings allied with electricity. It is rumoured that the application of the same process to another important metal is likely shortly to be announced. This company, which has already declared an interim dividend at the rate of 15 per cent., will, it may fairly be anticipated, continue to progress in the future in the same satisfactory manner as it has in the past.

D. H. BONNELLA.—We are in receipt of a circular announcing that Messrs. Martin and Co., of New Broad-street, E.C., and Mildmay Works, N., have transferred their business of ivory and hardwood turners for electricians, &c., to Mr. D. H. Bonnella, who will carry on business at 58, Mortimer-street, Cavendish-sq., W.

MESSRS. H. BINKO AND CO.—This firm has just issued a neatly got-up catalogue of electric bells, signals, telephones, lightning conductors, fire alarms, medical appliances, &c. Descriptions are given of Binko's patent portable telephone, of the "Dolphin" acoustic mechanical telephone, of the electric Binkograph, of the mechanical railway guard and passenger signal bell, with a number of other special manufactures of this firm. Like most other catalogues now issued by electrical firms, this contains some resistance tables, &c., and complete price lists. A section of the book is devoted to accumulators and fittings for the electric light, dynamos and motors. Several descriptions of portable lamps are illustrated, and a selection of fancy shades, electrical brackets, table lamps, &c. The book contains 116 well-illustrated octavo pages.

MR. ROBERT WOODLEY.—The premises occupied as workshops by Mr. Robert Woodley, electrical engineer, at Clemence-street, Burdett-road, Limehouse, were destroyed by fire on Saturday morning last. The cause of the fire is unknown. We are requested to announce that Mr. Woodley's business will be carried on as usual at the old address, 248, Burdett-road, E.

TUBES AND FITTINGS.—Messrs. J. E. and S. Spencer, of Great St. Thomas Apostle, Cannon-street, inform us that they have reduced their discounts 2½ per cent. less on the gross from wrought-iron tubes and fittings.

THE ELECTRIC LIGHT IN SYDNEY, N.S.W.—In a letter of December 4th Messrs. Wood Brothers and Co. write us:—"It may be interesting for you to know that we are now erecting plant to fulfil a contract we have undertaken to light by electricity the streets and houses of Moss Vale, which is a town 86 miles from Sydney, on the Great Southern Railway, the health-resort of Sydney and the country residence of the Governor of New South Wales, as also of many of the prominent men of the colony. We expect to have the street lights running by Christmas."

"THE YEAR-BOOK OF PHOTOGRAPHY FOR 1890."—Messrs. Piper and Carter, of 5, Furnival-st, Holborn, E.C., send us this very useful annual, containing about 400 pages of all kinds of information concerning the photographic act. A large number of our readers are no doubt interested in photography, and will be glad to know that the 1890 edition is now ready.

"COMMERCIAL LONDON."—We have received from the Intercolonial Publishing Company (Limited) the volume of "Commercial London" for 1890. The book is edited by Mr. Th. Simpson Jones, the editor of the *Eastern, Australasian, and South African Journal of Commerce*, consists of more than 500 pages, and contains a large amount of useful information. It is published at the low price of five shillings.

BOOKS, &c., RECEIVED.

"Journal of the Iron and Steel Institute." (London: E. and F. N. Spon.)

"The Ether Theory of 1839 is the True Theory of the Leyden Jar as established by Modern Electrical Discoveries." Part I. (Edinburgh: James Gemmell.)

"Professional Papers of the Corps of Royal Engineers." Vol. XIV., 1888. (Chatham: Royal Engineers' Institute.)

"Les Alliages." By W. Chandler Roberts-Austen. (Translated from the *Journal* of the Society of Arts, with the author's permission, by M. Gustave Richard.) (Paris: Gauthier-Villars et Fils.)

"Annuaire pour l'An, 1890." (Paris: Gauthier-Villars et Fils.)

LEGAL INTELLIGENCE.

United Telephone Company v. Tasker and Sons.

In this case, which came before Mr. Justice Kay in the Chancery Division of the High Court of Justice on Monday, the plaintiff company sought to restrain Messrs. Tasker and Sons from using or selling an instrument which was alleged to be an infringement of the well-known invention of Mr. Graham Bell as applied to telephones.

The Attorney-General, Mr. Aston, Q.C., Mr. Moulton, and Mr. Micklem appeared for the plaintiff company, the defendants being represented by Mr. Renshaw, Q.C., Mr. Bousfield, and Mr. Neill.

Mr. ASTON having briefly opened the case,

Mr. RENSHAW submitted to the injunction asked, to an account, and an inquiry as to damages. He then opened his counter-claim for damages in respect of an agreement alleged by him to have been entered into between the plaintiff company and the defendants, and contained in correspondence which passed between the parties from the years 1879 to 1884. By this agreement the defendants contended that they were authorised by the plaintiffs to establish in Sheffield a telephone exchange, and to promote a local company for that purpose; and, further, that the plaintiffs agreed to supply the defendants at a fixed price with such telephones as might be necessary to carry on the exchange, the defendants to be the sole agents of the plaintiff company for the supply of telephones in Sheffield. Subsequently the plaintiffs provided a rival telephone exchange in Sheffield with telephones, and refused to carry out their agreement with Messrs. Tasker and Sons.

His LORDSHIP, without calling on the plaintiffs, dismissed the counter-claim with costs, holding that the alleged agreement had not been established.

International Cable Company.

A petition, presented by Mr. A. S. Bolton, for the winding-up of this company, was in the paper for hearing before Mr. Justice Stirling on Saturday last.

Mr. GROSVENOR WOODS, who appeared for the petitioner, said he understood the company were desirous that the petition should stand over, and to this he had no objection, provided the company undertook to file their affidavits in opposition by Wednesday. He understood that the company intended to cross-examine the witnesses upon their affidavits.

His LORDSHIP directed that the petition should stand over.

In re James Fyfe.

On Wednesday at the London Bankruptcy Court, Mr. H. Brougham, an assistant receiver, presided at the first meeting of creditors under the failure of James Fyfe, St. Stephen's-chambers, Telegraph-street. The debtor states that he had gross liabilities of about £17,000, due to the fact of the gentlemen who agreed to buy his different patents having failed to carry out their original contracts. Previous to 1884 he was the managing director of the Pilsen-Joel and General Electric Light Company (Limited) but has not had any regular occupation since then. He acted as part promoter of the Ross Oil Lighting Company (Limited) in 1887, but received nothing for those services, the company having gone into liquidation. In July or August, 1888, he bought the patent with all rights of a new electric arc

Digitized by Google

light for £50, subject to a further payment of £600 to be made out of the profits. That patent was sold with all liabilities in August, 1889, for about £480, and he is now working it, jointly with another person, for the purchaser, who provides the necessary capital. He holds an agreement for shares in profits in the Brixton Improvements, a building scheme, of which he was a promoter; also an agreement for shares in profits for lighting the town of Los Palmas, in the Canary Islands, by electricity, of which scheme he was the promoter in England, and expects to receive one-third of the concession price. The debtor further is possessor of certain shares in the Foreign Pilsen Company and the Pilsen-Joel Company, but does not estimate they are of any value beyond the amount charged upon them. No accounts have yet been filed, and the Chairman stated that when the debtor had furnished his statement, in all probability a new meeting of creditors would be convened to deal with the matter. In the absence of any resolution, the matter will remain for the present in the hands of the Official Receiver.

COMPANIES' MEETINGS.

The Eastern Telegraph Company (Limited).

The 35th half-yearly ordinary general meeting of this Company was held on Thursday, January 16, 1890, at Winchester House, Old Broad-street, under the presidency of Sir John Pender, K.C.M.G.

The SECRETARY (Mr. George Draper) read the notice convening the meeting and the minutes of the thirty-fourth half-yearly ordinary general meeting held on July 18, 1889.

The CHAIRMAN, having signed the minutes, and the report being taken as read, said: Gentlemen, I suppose it is not too late in the new year for me to observe the good old Scotch fashion of wishing you a very happy and prosperous new year, not only in regard to this Company, but in regard to all other concerns in which you may be individually engaged. I think I may preface my remarks by saying that the report is a very full one, and if you look at the abstracts connected with that report, you will find that everything is accounted for, and that you have an amount of information given to you which almost, I believe, supplies all the knowledge that we ourselves possess. That has been our policy so far, and we desire that it should be maintained and continued. The gross revenue for the six months ended September 30, 1889, amounted to £351,014, as against £310,104 in the corresponding period of the previous year, showing an increase of £40,910. That is a very handsome increase, gentlemen. About £29,000 of it is derived from messages, and £12,000 from additional dividend on our increased holding in the Eastern and South African Telegraph Company. This is a matter to which I shall refer later on in my remarks. These figures show that the revenue for the past half-year has been exceptionally good, and the Directors hope this improvement will continue. I may mention that the revenue of this Company, as I have very often stated at these meetings, depends in great measure upon the state of the trade of the country. I have often said that the telegraph system is about the best barometer of trade, and I think that this is shown to-day; for while we admit that commercial prosperity has prevailed throughout the world generally, we show that we are participating in the improved state of things. That will always be the case, for I hope I shall show you in my remarks that, after all, the commercial prosperity and progress of this country are closely and immediately identified with the submarine system of telegraphy. The greater part of this increase in our revenue, I may mention, has been caused by the development of business in South Africa, but it is pleasing to note that, with one exception—viz., India—an increase has taken place in all classes of our traffic, owing to the general improvement in trade both at home and abroad. This general prosperity throughout the country affects almost every article which is dealt in by the aid of telegraphy. For instance, coal has largely increased in price, and I learn that such articles as gutta percha, copper, hemp, and iron wire—indeed all materials required for the manufacture of cables—have enormously increased in price. All that is an evidence that there are profits going, and that the general trade of the country cannot be prosperous without our participating in it. The total working expenses for the half-year amounted to £87,730, as against £83,332 in the corresponding period of 1888, or an increase of £4,398. The details of increase and decrease are as follows:—General expenses in London have been £8,411, as against £7,845, or an increase of £566. This is owing to the steady increase of our business requiring more hands, additional accommodation, &c. In other words, we cannot increase our business without increasing the facilities for conducting it. The working expenses at the stations were £64,712, as against £59,962, an increase of £4,750, the principal item of which is for salaries of the additional staff required. The staff has been increased by some 40 additional manipulators at our stations. Each of these young men is paid a fair salary, and therefore if you take that increase in our staff, the amount of increase in the expenditure at the stations is not a very large one. We also considered it expedient to grant some increases of salary to our older *employés*, more particularly the superintendents and clerks at stations. They have done their duty in a thoroughly satisfactory manner, and have, together with the heads of departments in London, had much to do with the building up of this concern, and we must not forget them in the midst of our prosperity. Therefore, when we have something to spare we are always desirous of recognising those who are entitled to our consideration. The repairs to cables amounted to £49,634, as against £43,075 in the same half of the previous year, being an increase of £6,559, full details of which will be found under abstract "C" in the accounts, which is really a very interesting abstract. It shows the expenses of our steamers, and at the same time indicates the improvements that are being made in our property. These steamers go moving about from place to place, conducting repairs in the most silent way. We scarcely hear now of interruptions, and the reason of that is that we have made our system almost as perfect as it is possible to do. But I have often stated on these occasions that a single line of telegraph is not to be relied on. Unless you have a duplicate line you cannot maintain that continuity—you cannot give confidence to merchants who are relying on the telegraphs, and who require confidence in connection with the successful conduct of their operations. Two days ago I saw reported the enormous tonnage of the world—many, many millions of tons—and 75 per cent. of the whole amount is in British bottoms; and when I tell you that, you will see what a solid foundation there is for our submarine system of telegraphy. There is not a ship that does not more or less in the course of the year have to use our system, which, therefore, has the deepest root it can have, and the widest area for expansion of any existing system that I know of in the world. The other day it was considered the great feature of the age in politics, but I say that in commerce it is a greater factor still. We who have been associated with submarine telegraphy from the beginning have every reason to be pleased with the results we have achieved, and with the position that we are in to-day in regard to our dividends. We do not profess to go in for extreme dividends, but we have tried to put by such an amount as will secure not only the present, but build up great security for the future; and as we strengthen our foundations so we shall be able in the future, I hope, to increase our dividends. This is not a yearly, but a half-yearly account. Referring to the speech I made six months ago, I gave you then a very full amount of information, and if I were to repeat it to-day it would show pretty well the position we are now in; but I do not intend to refer to it further than to say this—that the large amount we are carrying forward—over £60,000—will be dealt with at the next half-yearly meeting, and I hope it will be dealt with in such a way as will be satisfactory to those who are interested in it. In that £60,000, I may say there is a satisfactory bonus, and if the next six months are as successful as the past we shall have something to do in that direction. I have given you a certain amount of detail as to the working of this concern. There is one other point that I wish to draw your attention to, and that is in connection with the map that is behind us. This great dark country, as it is called, is now being opened up, and last year we finished the complete circuit of the whole of this dark country—Africa; and I then remarked that this was, I believed, the largest thing that had yet been done in connection with submarine telegraphy. I pointed out to you that the completion of this system involved something like 17,000 miles of cable. No other company could attempt to do anything of the kind. Therefore while other countries are striving hard to get a footing in Africa we are pioneers of the whole thing. We have put ourselves in such a position that at every point of the seaboard we are in communication with the old country. That is a very important position to be placed in; and in referring to those who have more or less benefited us and assisted us in that enterprise I am bound to say that England has done a very great deal. The English-speaking people, you may say, have made Africa up to the present point, and as long as the English tongue and the enterprise which follows it continue, we have a wide field for development in Africa. Portugal has been kind, generous, and liberal to us, whatever may be said of her want of enterprise in the development of her colonies. As far as we are concerned, Portugal has done everything in connecting its colonies with the mother country, and has assisted in every way. France has done the same to some extent, and so has Spain; but, curiously enough, the only country that has not assisted us in any way is Germany. Germany is now trying to get a hold in that country, but I may mention that to get a hold there they find they must do something for submarine telegraphy. We do not connect with many of their ports, but where we do they get all the benefit that other countries receive without having contributed one shilling. I mention this fact, and it may get to the ear of the German Government. Five years ago I drew their attention to it when we were going into our scheme for African extensions. They have, however, been making inquiries, and I hope next time I meet you I shall be able to state that Germany is taking part in the system of submarine telegraphy, which is doing so much good. Our policy generally is, as far as possible, to follow the trade and flag of England. As you are aware, Africa is now in a state of transition. There are two very important companies there—the Imperial British East Africa Company, and the British South Africa Company, both in the hands of bold, intelligent, and large-minded men. There will be rapid development there, and we have, therefore, without hesitation, laid a cable (I believe it is completed to-day) from Zanzibar to Mombassa, the headquarters of the Imperial British East Africa Company. That is a Company working under a Royal Charter. England is the suzerain, and the result will be, I hope, very rapid development. We have, however, done our part, we have followed the flag, and I hope we shall get the benefit from increasing trade in the traffic over that section which we have laid, because it puts them in connection with the whole of the civilised world. That shows you our policy so far. I may now use a phrase which is very often used by greater people than ourselves, that we are on very friendly relations with almost—in fact with every Government of the world. Only the other day our friend the Emperor of Morocco visited Tangiers. He was so opposed to our system at one time that he objected—and strongly objected—to our landing there; but we did so at last, and on the occasion of his visit His Majesty was so pleased with what he saw, that instead of reviling us, he presented us with a site to build an office upon, so that it might be an evidence of his goodwill towards the Company. We consider that a very great compliment to us. Our relations with the Sultan of Zanzibar are very similar. He gives us every possible facility. He has also given us a site and a house for our station, and our relations with him are thoroughly satisfactory. Two days ago we concluded with France agreements which will extend over the next 20 years. They were renewals of agreements that have existed, and which have been thoroughly satisfactory to us, for the last ten or twelve years. Those agreements will give us—what shall I say?—a very strong hold indeed upon the Mediterranean

Digitized by Google

system of telegraphs. We shall be able to run lines from Marseilles to Malta and Algiers. Those arrangements are as satisfactory to France as to us, and to the senders of messages. There is another point which I may mention in reference to this branch of my remarks. I have always tried to impress upon the shareholders that we want this submarine telegraph to have an international character. We cannot work it ourselves as a monopoly. We must work it for the whole world, and the whole world gets the same benefit from it as England does. We have no advantage which any other country does not possess in connection with this system, so that we have a broad field for our work. I find by degrees that the different countries are recognising this, and that on the whole they are very friendly towards us. I have one other subject to bring before you. We have generally received some suggestions and letters from some of our careful proprietors when the meeting of the Company is going to be held; but I think, so far as this meeting is concerned, only one letter has come to hand. It was addressed by a shareholder to Sir James Anderson, who was asked whether the Telegraph Conference that is to be held in Paris this year is likely to reduce our rates, and consequently to interfere with our dividend. The Telegraph Conference was held last at Berlin five years ago, and another conference will be held in Paris this year. But such is our position—such I think is the strength of our position—that we are so useful to all nations, that I do not see well how they can interfere with us, or do us any serious harm. They may want to reduce our rates; but we have this answer to give them: that there is not a Power in Europe whose land telegraph system is earning them a profit. Therefore, we say that it may be very easy for them to reduce their rates if they choose to do so out of the public money, but it would not be fair for them to do anything that will interfere with a Company which is so greatly benefiting them and the world generally. It would not be fair or right to reduce our rates in such a way as seriously to injure the Company, and at the same time practically injure the populations themselves of the countries that will be represented at the Conference. We think our arguments are very strong, and we hope that when the time comes, while we are always willing to deal with things in a fair spirit, our arguments will be such as will enable us to hold our position. Whatever concessions we make shall be made in a direction that will bring increased traffic, and consequently the exchequer will not lose by the concessions. That is the policy we intend to pursue. We have now a little difference of opinion in Egypt. I intend to proceed to that country a few days hence, and I hope my visit will be instrumental in settling this little difference. This I do know, that we have right on our side, and I am always prepared to fight a strong and hard battle as long as we feel that we are not asking anything to which we are not fully entitled. I think that exhausts every point that I need address you upon. I thought when I began to speak that I had said so much six months ago that it would not be necessary to say much on this occasion, but, really, when I begin to talk about submarine telegraphy, I am afraid that I do not know when to stop. I will, however, now move:

"*That the report and accounts of the Directors to September 30, 1889, submitted to this meeting, be and the same are hereby received and adopted.*"

The VICE-CHAIRMAN (the Marquis of Tweeddale): I beg to second that.

The CHAIRMAN: If any gentleman desires to ask any question before I put the motion, I shall be very glad to listen to him. Those in favour of the motion please hold up their hands. To the contrary. Carried unanimously. The next motion is:

"*That George Garden Nicol, Esq., who now retires, be and is hereby re-elected a Director of the Company.*"

Just let me say one word on this motion. It is rather remarkable what I am going to tell you. Mr. George Garden Nicol has been a friend of mine for a longer period than I choose to tell you; but you saw the very laudatory remarks which were made the other day in the *Times* about the enormous prosperity which has attended our colony of Hong Kong. Mr. Garden Nicol, who has been associated with us in all the progress of this great Company, who sits at this Board to-day, was landed at Hong Kong when I suppose there were not a hundred people located on it—long before the British Government took possession of it, and now it has become what I may almost call a model colony of England.

Sir JAMES ANDERSON: I beg to second the motion.

Mr. CLARKSON: I wish to question the expediency of the everlasting system of duplicating and triplicating ——

The CHAIRMAN: I am afraid you are too late. I invited you to speak on the report.

Mr. CLARKSON: You did not give me time.

The CHAIRMAN: I paused some time.

Mr. CLARKSON: No, you put the motion instantaneously.

The CHAIRMAN: If there is anything interesting you have to say, and the shareholders choose to listen ——

Mr. CLARKSON: I do not care whether I stay here three centuries or three months, I am determined to have my say. ("Chair! Chair!")

The CHAIRMAN: I do not want to stop you.

Mr. CLARKSON: Never mind that, I am determined ——

The CHAIRMAN: You are in the hands of the meeting.

Mr. CLARKSON: I am in the hands of myself. I have been a shareholder for 17 years, and I am determined to have my say.

The CHAIRMAN: Will you come forward and say what you have to say?

Mr. CLARKSON: I will say what I have to say here.

The CHAIRMAN: What is your name?

Mr. CLARKSON: Mr. Clarkson.

The CHAIRMAN: I want to conduct this meeting as we have always done before. We have done things in a regular and proper way. If it is the wish of the body of shareholders to listen to this gentleman, I have no objection to listen to him. I put it to you whether you desire to listen to this gentleman or not.

Mr. CLARKSON: Then I say I will be heard. I have been a shareholder for 17 years.

The CHAIRMAN: Those in favour of this gentleman addressing the meeting hold up their hands.

Mr. CLARKSON: Let us have fair play.

Mr. FILER: Will you let me suggest that this gentleman have a hearing? He may have very peculiar notions. All of us have strange notions. I have not the least knowledge of him, but I feel sure that our time will be saved if you listen to him.

Mr. CLARKSON: That it will. You are a gentleman.

The CHAIRMAN: There is a desire to take the sense of the meeting as to whether this gentleman is to speak or not. Those who desire that he should speak please hold up their hands (counting); five desire that he should speak. On the contrary (counting); you are not allowed to speak.

Mr. CLARKSON: Are you ashamed of what I am going to say? I shall stay here if necessary for three centuries. As long as one drop of blood flows through my veins I am determined to have my say.

The CHAIRMAN: If you do not keep quiet I shall cause you to be removed from this room.

Mr. CLARKSON: I am going to say what I know about my property. I am determined to have my say. I am determined to stay here if necessary for three centuries.

The CHAIRMAN: We will give you accommodation. Those in favour of the re-election of Mr. George Garden Nicol, please hold up their hands. That is carried.

Mr. NICOL: I beg to return you my thanks for the compliment you have paid me, and I can assure you that my exertions shall be given in the future, as they have been in the past, to promoting the welfare of the Company.

Mr. CLARKSON: As you are re-elected, now help me.

The CHAIRMAN: I now beg to move—

"*That John Denison Pender, Esq., who now retires, be and is hereby re-elected a Director of the Company.*"

The VICE-CHAIRMAN: I second that.

The CHAIRMAN put the motion, and it was carried.

Dr. WALLER: I have the honour to move a resolution which has been placed in my hands with reference to the election of the outgoing auditors. I am sure there will not be a dissentient to that. I propose—

"*That Mr. Henry Dever and Messrs. Welton, Jones, and Company, both of whom now retire, be and they are hereby re-elected auditors of the Company for the current year, at a remuneration of £100 each.*"

Mr. CROCKFORD: I have great pleasure in seconding the motion. I think the evidence of these gentlemen's ability has been in our hands in the wonderful report that has been placed before us. It is as clear and lucid as it can be, and I think it is our bounden duty to re-elect these gentlemen.

The CHAIRMAN put the motion, and declared it carried, adding, that closes the business of this meeting.

Mr. CLARKSON: Now it is my turn. You gave me your word that you would hear me.

The CHAIRMAN: I said I would give you accommodation to stay here.

Mr. CLARKSON: I question the expediency of this everlasting system of laying duplicate and triplicate cables. I have been a shareholder for 17 years, and during the past eight years there has been a cable—— (interruption).

Major LESLIE proposed a vote of thanks to the Chairman.

Dr. WALLER seconded the motion.

The SOLICITOR (Mr. Burt) put it to the meeting, and it was carried.

The CHAIRMAN: I am very much obliged to you.

The proceedings then terminated.

The Direct United States Cable Company (Limited.)

The twenty-fifth ordinary general meeting of this Company was held at Winchester House, Old Broad-street, on the 17th inst., under the presidency of Sir John Pender, K.C.M.G.

The SECRETARY (Mr. T. Finnis) read the notice convening the meeting and the minutes of the last general meeting, which were approved by the present meeting, and signed by the Chairman as correctly entered.

The report of the Directors and statement of accounts were taken as read.

The CHAIRMAN: Gentlemen, I shall as usual go over some of the details of the accounts, and refer a little to what has been going on in our system during the last six months. The revenue for the half-year to December 31st last, after deducting out-payments, amounted to £42,356, and the working and other expenses, including income-tax, but excluding the cost of repairs to cable, were £15,509, leaving a balance of £26,847 as the net profit of the half-year, making, with £2,719, brought forward from the previous half-year, a total of £29,566, which has been appropriated as follows:—Interim dividend of 3s. 6d. a share to 30th September last, £10,624 5s.; interim dividend of 3s. 6d. a share to 31st December, £10,624 5s.; total dividend for the two quarters, £21,248 10s.; balance carried forward to next half-year £8,318—total £29,566. The revenue for the six months at the 1s. tariff shows an increase of £8,168 over that of the corresponding period of 1888, when, however, the tariff was at 6d. for two months and at 1s. for four months. The business of the last four months showed a small increase over that for the corresponding period, when the tariffs were the same. This increase would have been larger but for the interruption to several of the Pool cables in the period compared. I may mention that the Pool traffic at the 1s. rate shows a reduction of something like 20 per cent. as compared with the traffic at 6d. That shows you, gentlemen, that

Digitized by Google

while at the moment when we were working at 6d. there was a very considerable rush of traffic; now that we have settled down, the difference between the 6d. and 1s. rate is about 20 per cent. On the other side of the account a comparison of the expenditure, where it is not practically the same as in the corresponding period of the previous year, shows as follows: In London a reduction of £106 in printing and stationery. On the whole of the London items there is a total saving of £140. At the stations the increases are as follow: £385 in salaries in giving a little promotion to several of our operators, who thoroughly deserve it; £32 in travelling; £32 in medical expenses, and £26 in banking commission. The reductions are as under: £343 in maintenance, £235 in repairs and renewals, and £117 in printing and stationery: for the whole of the stations the reduction is £200. In the remaining expenses there has been a reduction in the law charges of £23, in the duplex royalty of £317, and in insurance of cable £135. On the other hand, the income tax is £82 higher. Excluding the cost of repairs the Company's expenditure during the past half-year is the lowest on record for any corresponding period since the formation of the Company. With regard to the interruptions of the cable, every effort was made, and with complete success, to secure prompt repairs, and the importance of this, particularly during times of competition, cannot be overestimated. It may be mentioned in the present case that, had the repairing steamer been delayed for another three or four days, the repairs effected on the 12th November would in all probability have been prevented for five or six weeks through the bad weather which prevailed, thereby largely increasing the cost of repairs and adversely affecting the Pool revenue. I may mention that that is one of the points in the policy of this Company that we have strictly adhered to, and in carrying it out we have never yet had any reason to regret—that is, when the cable is broken the sooner we can get a ship sent to repair it the better. We have sent out our ships in all weathers. We have been told it was no use sending a ship in this and that weather; but, gentlemen, the weather here is very different from what it may be where we want to go to. At all events, taking our policy as a whole, it has been successful. Had that policy been strictly practised all round, there would have been, I believe myself honestly, £20,000 more in the pool to divide to-day than there is, on account of the delay in repairing the cables. That is a very large sum, £20,000, in the half-year, and I am quite certain that the example your small company has set will be noticed, and probably noticed for good in the conduct of submarine business generally in the future. The reserve fund account, after being credited with £4,098, the interest on investment, and debited with £4,119, the cost of repairs, now stands at £242,027. No addition to the fund has been made this half-year out of revenue, but this is only the interim half-year, and it must not be overlooked that the Company's cable has, in the course of the last two years, been renewed in parts to the extent of about £35,000. At the last half-yearly meeting, in referring to the reserve fund, I stated that that fund would have to be looked to at no very distant date. I am not going to make any proposal to you to-day with respect to the reserve fund, but six months hence, at the termination of our financial year, I shall make a proposal which I think will strengthen the Company, and will not materially change the dividend. We must try and find out some way of keeping up our income. At the same time, we must find some way of building up the reserve fund, which we have drawn upon pretty frequently. During the time of the competition we were anxious to keep our shareholders as happy as possible, seeing that there was a reduction in our dividend, and £25,000 was applied out of reserve fund towards the payment of dividends, and now that we are working at a higher rate we must try and put our reserve fund in as good a position as it stood at in previous years. At the same time, I am bound to say that while we have drawn from the reserve fund and have put the money into the cable, it has improved the value of our property, so that by adding a certain amount of good cable from time to time to our present cable we should find at the end of a certain number of years that we had replaced it out of reserve fund, and made that fund a strong arm of strength to us in the event of another cable being required. These are details which I think we are justified in putting before you as fully as we possibly can. I always think that the more confidence the shareholders have in the directors the better the machine works altogether. I may now tell you that the company's investments, standing in the balance-sheet at £239,180, are now worth about £264,000, or nearly £25,000 more than they cost the Company. Therefore, you see your securities are not being badly managed after all. I have now given you all the information probably that I originally intended to give you in connection with the working of the Company, but I think it may interest you just to take a short review of this Company, because I think I can show you that after all, at the present moment, with the present dividend, we are in not at all an unsatisfactory position. The dividend paid when only six or eight cables were in the Atlantic was 5 per cent. We accumulated then a considerable amount of reserve, and, as I told you, that reserve has proved very useful to us. The dividend now paid is 3½ per cent., but there are now ten cables to share in the traffic. Therefore, you see, we have in the Atlantic now ten cables against six, and we are paying 3½ per cent. against 5 per cent. It is a very curious fact that when our tariff was 2s., and when we had six to eight cables in the Atlantic, our earnings never quite reached a million sterling. I believe we got to £950,000, but never to a million, which it was our ambition to get to. Something, however, occurred, and the result was that we never reached that point. We are now working at 1s., and we have altogether got to very close upon £800,000, but that £800,000 has to be divided among ten instead of, as before, six cables. That makes a great difference. I want to show you this, that it is very remarkable how little the revenue from Atlantic traffic has progressed during these years—that is to say, the money that has been got out of the Atlantic by the cables has varied from between £500,000 and £950,000, and now with a sort of medium price we are standing with a gross income by all the companies of about £800,000. I should like very much to see the million back again if it is possible to do it. I believe it is possible to do it, but I do not see my way at all to change the 1s. tariff. There is, however, a sort of system prevailing abroad now that property must be a little more taxed, and that the labouring man must go with a less burden on his shoulders, and I think we must go with the fashionable idea, and see if we cannot get a little more out of the moneyed people, and leave the other class of our customers to enjoy a low and satisfactory rate. We must do something, and exercise our ingenuity to try and get up our traffic a little. But with all that I am bound to say to you that the position of the Company now, as compared with what it was when the present Board became the executive, is a satisfactory one. At that time we had 483 shareholders, but we have now got 1,306—of this number only about 8 per cent. are old shareholders, the remaining 92 per cent. being members who have come in since 1887. When we began to agitate, the shares of this Company in the market were about £7. They rose upon our agitation to £12. They even went higher than £12. When we took the Company in hand there was a very heavy debt of £100,000, which we in a very short period cleared off. More than that, our shares are £20 shares. They stand in the market to-day at about £10, but you are getting 3½ per cent. on £20—in other words, those who came later into the concern along with us are practically getting their 6½ per cent. to 7½ per cent. for their money, which is not a bad investment in these times. It is a very difficult thing for a man who is desirous of investing his money to get more than from 3 to 4 per cent. for it. Therefore, I say, taking things all round, we are not in a very unsatisfactory position. As I said, I have referred to two or three points which I thought would be interesting to you, and I will now conclude by saying this, that our cable was never in a better working condition than it is at the present time. When breaks occur we are apt to lose custom, but there has been a steady increase in our customers during the last three months. If

PATENT
SILICIUM BRONZE AND SILICIUM COPPER WIRE.
The best for overhead Telephone and Telegraph Lines,
AND ALL ELECTRICAL PURPOSES.
Hard Drawn High Conductivity Copper Wire.
ROLLED AND DRAWN
PHOSPHOR BRONZE.
PHOSPHOR BRONZE
BEARINGS, BUSHES,
AND OTHER PARTS OF
ELECTRICAL MACHINERY.
SOLE PROPRIETORS of the British, Indian and Colonial Patents,
THE PHOSPHOR BRONZE COMPANY (Limited),
87, Sumner Street, Southwark, London, S.E.
WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

Digitized by Google

I take our capital, our earnings, and our reserve fund, I think I may say, without any hesitation, that there is no Telegraph Company existing at the present time that occupies a sounder and better position than the Direct United States Company. With these remarks, I beg to move—

"That the report of the Directors, dated January 8, 1890, together with the statement of accounts to December 31, 1889, annexed thereto, be, and the same are, hereby received and adopted."

Mr. WILLIAM FORD: I beg to second that.

The CHAIRMAN: I shall be glad to answer any question that any shareholder wishes to ask before I put the resolution. No one rising to address the meeting, he put the motion, and declared it carried unanimously. Continuing, he said: I think that concludes the business of the meeting, and if I am spared to meet you here six months hence, when we come to the end of our financial year—when we shall talk more about our finances than we have done to day—I hope we shall have as pleasant a meeting and as happy a termination to it as we have had to-day.

Mr. HANCOCK proposed a cordial vote of thanks to the Chairman, Directors, and staff. He expressed disappointment at not seeing the traffic increased as he had expected, in view particularly of their being so many Americans in Europe. The position of the Company he regarded as very much superior to what it was some time ago, and altogether he thought the position, if not quite satisfactory, was full of promise for the future. He thought that the publication of the returns of the traffic might now be resumed.

Mr. VARLEY, in seconding the motion, expressed his satisfaction at the intimation of the Chairman with regard to increasing the reserve fund.

Mr. HUMPHREYS said a few years ago the American cable companies used to publish their returns, but he was opposed to it very much, and at length the system ceased, and with it all its attendant evils. He trusted for his own part that the system would not be renewed.

The CHAIRMAN, in reply, attributed the fact that the traffic had not increased so much as some of them had anticipated to the coding system adopted, especially by merchants. He was astounded at the vast amount of information which could be expressed in two words only by means of those coding systems, which could not be stopped. In fact, it was the growth of this system of coding which prevented their own growth. Submarine cable companies must rely for their progress in the future upon the necessity which their systems had now become to merchants and to every class of the community. With reference to the reserve fund, that was the strength of any company. In their own concern they had not aspired so much to high dividends, and for that reason they had always preferred to strengthen the reserve fund rather than pay, as they occasionally might have done, ½ per cent. extra to the shareholders. They could not publish the returns of the traffic alone owing to their agreements with other companies, and he did not think it would be advisable to do so under the circumstances. He thought, too, that by the publication of the returns artificial speculation on their property might be created, and that would be prejudicial to the interests of the shareholders. Every half-year, however, in the report and accounts which they furnished, they gave the shareholders very full information, enough, he thought, to afford them ample food for digestion during the following half-year. On the part of the Directors, he was much obliged to them for their vote of thanks. The Board appreciated the confidence of the shareholders highly, and trusted that they would always enjoy it.

The proceedings then terminated.

NEW COMPANIES REGISTERED.

THE PURNELL HIGH-SPEED GAS ENGINE AND MANUFACTURING COMPANY (LIMITED).—Registered by Paddison, Son, and Fullilove, 14, Gray's Inn-square, W.C., with a capital of £50,000 in £1 shares. Object: To carry into effect an agreement made January 2nd between J. J. Purnell and J. White on behalf of the Company, and to acquire the patents, inventions, and improvements, machinery, business, and contracts referred to in the said agreement.

THE ELECTRICAL ENGINEERING CORPORATION (LIMITED).—Registered by Dowson, Ainslie, and Martineau, 28, Bedford-row, W.C., with a capital of £150,000 in £5 shares. Object: To carry into effect two agreements, dated January 9th, and made between R. B. Rennie (on behalf of the United Electrical Engineering Company) and John G. Statter (on behalf of the Company), and John G. Statter (on behalf of J. G. Statter and Co., Limited) and E. Manville (on behalf of this Company), being agreements for the transfer to this Company of the respective businesses of the United Electrical Engineering Company (Limited) and J. G. Statter and Co. (Limited). The first subscribers are:—

C. Sannel, 175, Sutherland-avenue, W.
W. L. Madgen, 3, Princes-mansions.
W. G. Ainslie, M.P., 21, Ennismore-gardens.
J. G. Statter, C.E., Alliance Engineering Works, West Drayton.
H. B. Statter, Old Hall, Snapethorpe, near Wakefield.
P. E. Scrutton, Alliance Engineering Works, West Drayton.
E. Manville, 3, Princes-mansions, S.W.

There shall not be less than three nor more than nine directors. The first are W. Statter, H. B. Statter, J. G. Statter, C.E. Charlesworth, C. Sannel, W. G. Ainslie, E. Manville, and W. L. Madgen, of whom J. G. Statter, E. Manville, and W. L. Madgen shall be managing directors. Qualification £500. Remuneration, £250, and one-tenth of profits after 10 per cent. dividend.

CITY NOTES, &c.

ANGLO-AMERICAN TELEGRAPH COMPANY (LIMITED).—At a meeting of the Board of Directors of this Company, held on Friday last, it was resolved to recommend to the proprietors at the next half-yearly genera meeting of the Company, to be held on the 31st inst., the declaration of the following dividends:—1. A balance dividend of 15s. per cent. upon the ordinary Consolidated Stock for the year ended December 31, 1889. 2. A balance dividend of £1. 10s. per cent. upon the Preferred Stock for the year ended December 31, 1889, both payable on February 1st next, less income-tax, to the stockholders registered on the books of the Company on the 13th inst. After paying the foregoing dividends there will be an estimated balance of £2,247 to be carried forward to the next account. The above dividends, together with those already paid will amount to £2. 15s. per cent. on the ordinary Consolidated Stock, and £5. 10s. per cent. on the Preferred Stock for the year 1889. The register of transfers will be closed from the 17th to the 31st inst., both days inclusive. The ordinary general half yearly meeting will be held at Winchester House, Old Broad-street, E.C., on Friday next, January 31st, at 2 o'clock.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended January 17th amounted to £4,759.

CUBA SUBMARINE TELEGRAPH COMPANY.—This Company, after providing for the dividend on the Preference shares, and placing £1,000 to the reserve fund, recommend a dividend on the ordinary shares at the rate of 9 per cent. per annum, tax free, leaving £404 to be carried forward.

EASTERN TELEGRAPH COMPANY.—This Company announces the opening for traffic of a new cable between Zanzibar and Mombassa on the East Coast of Africa. The rate for telegrams to Mombassa will be the same as to Zanzibar.

EASTERN AND SOUTH AFRICAN TELEGRAPH COMPANY.—This Company announce the payment by interest warrant, on February 1st next, of interest for the half-year ended January 31st on their Four per Cent. Mortgage Debentures.

WESTERN COUNTIES AND SOUTH WALES TELEPHONE COMPANY (LIMITED).—Warrants for the interest on the Preference shares of this Company to December 31st last, payable at the National Provincial Bank, Bristol, on the 21st inst., were posted on Monday last.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended January 17th, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,432.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The receipts of this Company for the half-month ended January 15th show an increase of £476 as compared with the corresponding period.

WOODHOUSE AND RAWSON UNITED (LIMITED).—The Directors of this Company have decided to pay an interim dividend for the half-year ended the 31st December last, in respect of profits realised since the formation of the Company, at the rate of 8 per cent. per annum on the Preference shares and of 15 per cent. per annum on the Ordinary shares of the Company, payable on the instalments from the date of their payment.

THE NON-CONDUCTOR OF ELECTRICITY.

VULCANISED FIBRE,

PATENTED.

This new material is supplied in two qualities, Flexible and Hard.

The FLEXIBLE is a substitute for Leather, Rubber, Gutta Percha, &c., and is extensively used by Brass Founders, Axle Makers, Hydraulic, Sanitary, and other Engineers, Pump Makers, Carriage Builders, &c.

It makes the best Hot and Cold Water Packings, and for Axle Washers of all kinds it is unequalled.

The HARD is a substitute for Metals, Hard Wood, Ivory, Vulcanite, Ebonite, &c., and is a good Insulator.

Sold in sheets, 5ft. 6in. by 3ft. 6in., varying in thickness from 1-50in. to 1in.

FLEXIBLE, 2/- per lb.; HARD, 2/3 per lb.

MOSSES & MITCHELL, 70 Chiswell-st., London, E.C.

Digitized by Google

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Wednesday, Jan. 22, 1890.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending Jan. 22, 1890.	
					£ s. d.		Highest.	Lowest.
			TELEGRAPHS.					
£ 1,770,360	Stock	12/6	Anglo-American	51 52	5 5 9	Jan., Apr., July, Oct.	52¼	52⅛
2,614,820	Stock	25/0	Do. Preferred	87 88	6 5 0	,, ,,	88	87
2,614,820	Stock	...	Do. Deferred	15⅜ 16¼	...	February	16⅜	16¼
130,000	£10	3/0	Brazilian Submarine	12 12½	6 0 0	Mar., June, Oct., Dec.	12½	12¼
112,900	£100	5%	Do. 5 per Cent. Bonds	101 103	4 17 1	January and July	...	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	104 107	4 13 6	June and December.	...	...
16,000	10	9/0	Cuba Submarine	14⅛ 15	6 0 0	February and August	14⅜	...
6,000	10	10%	Do. Preference 10%	19½ 20½	4 19 9	,, ,,	...	...
12,331	5	2/0	Direct Spanish (£4 paid)	4 4½	4 8 11	March & September	...	...
6,000	5	10%	Do. Preference 10%	9 10	5 0 0	April and October	...	...
60,710	20	3/6	Direct United States xd	10 10⅛	6 13 4	Jan., Apr., July, Oct.	10 5/8	10
380,000	10	2/6	Eastern xd	13⅝ 14⅛	4 12 0	,, ,,	14⅛	13⅞
70,000	10	3/0	Do. 6 per Cent. Preference xd	15 15⅛	3 17 5	,, ,,	15⅜	15
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock	105 107	3 14 9	May and November.	106⅛	105¼
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	107 110	4 10 11	February & August	109⅛	...
250,000	10	2/6	Eastern Extension xd	13⅜ 14	4 12 10	Jan., Apr., July, Oct.	14	13⅜
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	102 104	3 16 1	February & August	...	...
473,000	100	5%	Do. 5 per Ct. (Austrln. Gov. Sub.) Debs. 1900	102 105	4 15 3	January and July	104	...
179,177	10	2/0	Globe Telegraph and Trust	8⅜ 9	5 13 7	Jan., Apr., July, Oct.	8⅞	8⅞
178,992	10	6%	Do. 6 per Cent. Preference	14⅜ 14⅞	4 0 8	,, ,,	14⅞	14⅜
150,000	10	5/0	Great Northern	15½ 16	4 13 9	Jan., July, and April	16	15½
17,000	25	12/6	Indo-European	41 43	5 16 3	April and October	...	...
9,000	8	4/0	Reuter's	7 7⅛	5 6 5	April and October	...	...
15,609	10	3/6	West African Telegraph	9⅛ 10⅛	...	...	...	...
300,000	100	5%	Do. 5 per Cent. Debentures	99 102	4 18 0	March & September	101⅛	101
30,000	10	5/0	West Coast of America xd	11 11½	4 6 11	January and July	...	...
150,000	100	8%	Do. Debentures 8%	119 124	6 9 1	June and December	...	...
88,321	10	nil.	West India and Panama	2⅞ 3⅛	...	...	3	2⅞
84,563	10	12/0	Do. 1st Preference 6%	11⅜ 12⅛	...	April and October	12⅛	11⅞
4,669	10	10/0	Do. 6 per Cent. 2nd Preference	14⅛ 15⅛	3 17 5	...	...	...
45,181	15	6/0	Western Brazilian	9⅞ 9⅞	7 13 10	May & November	9⅞	9½
$1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	118 122	5 14 9	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	100 102	5 17 2	March & September	...	...
			TELEPHONES.					
224,850	14/0	5%	Consolidated Telephone and Maintenance	⅞ 1⅛	...	Yearly	...	...
220,000	£1	3%	Oriental (11s. paid)	⅞ ⅞	3 15 11	...	...	...
*	*	6%	National	5½ 5⅝	...	...	5⅛	5⅛
55,000	5	3/0	United River Plate	4⅜ 5¼	...	January and July	...	...
			ELECTRIC LIGHT.					
500,000	10	...	Metropolitan Electric Supply (£3 paid)	4⅜ 5⅛	...	...	...	...
79,934	5	6%	Swan United (£3. 10s. paid)	5⅜ 5⅝	...	...	5⅝	5 5/8
			MISCELLANEOUS.					
87,350	12	12/0	Telegraph Construction and Maintenance	44 46	5 4 9	March and July	46	45
41,600	10	10/0	India Rubber, Gutta Percha & Telegraph Works	17⅛ 18⅛	5 8 1	February & August	18	17¼

JABLOCHKOFF'S
DISTRIBUTION PATENT

(Being a Patent for "Producing and Dividing Electric Light," No. 1996 of 1877.)

THE UNITED ELECTRICAL ENGINEERING COMPANY (LIMITED)

Are Proprietors of the above Patent, and Warn the Public against Infringement.

The following are Licensees:—

Anglo-American Brush Electric Light Corporation, Limited.
Crompton & Co., Limited.
S. Z. de Ferranti.—London Electric Supply Corporation, Limited.
W. T. Goolden & Co.
Hammond & Co.
Wilson Hartnell.
Johnson & Phillips.
Laurence, Paris & Scott, Limited.
Nalder Brothers & Co.
Paterson & Cooper.
Ernest Scott & Co.
Siemens Brothers & Co., Limited.
J. G. Statter & Co., Limited.

3, Prince's Mansions, Victoria Street, Westminster.

MANVILLE & MADGEN, *Managing Directors*

Digitized by Google

THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 611.—Vol. XXIV. FRIDAY, JANUARY 31, 1890. Price Fourpence.

NOTES.

The discussion on the Presidential Address at the Institution of Electrical Engineers yielded several points of interest. Prof. Thompson described an admirably simple piece of apparatus, which he had previously shown at his first Cantor Lecture, for workshop use, for determining the permeability of different specimens of iron. This should prove a useful addition to present testing appliances. Mr. Preece complained of the falling off in the magnetic quality of steel, and his remarks were supported by Mr. Evershed. It was stated that, whereas in 1883 it was possible to get steel having a permanent induction of over 5,000 C.-G.-S. lines, in 1886 the best that could be obtained had only 3,700 lines, and that recent tests show even further deterioration. The important uses of permanent magnets in testing instruments and for other purposes renders this matter worthy of serious attention. We think it doubtful whether this falling off is very general, for Prof. Gray has, we believe, succeeded since 1883 in permanently magnetising steel to an induction of over 7,000 C.-G.-S. lines.

The constantly-recurring subject of electrical terminology was alluded to by several speakers. A word is certainly needed to denote the practical unit of lines of force, which is 10^8 C.-G.-S. lines per square centimetre, although we hardly like the one proposed by Mr. Evershed. The name *Thomson*, like the word *induction*, is suggestive of too many ideas to be confined to one.

The Friday evening lectures at the Royal Institution were appropriately opened last week with an address on "The Scientific work of Joule," by Prof. Dewar, who admirably fulfilled the task which, had he been able to leave Scotland, Joule's fellow-worker, Sir William Thomson, was desirous of undertaking. In the short time at his disposal, Prof. Dewar rapidly reviewed the great field covered by Joule during his 40 years of constant scientific research, illustrating several of his points by striking experiments. The lecture was concluded by the reading of some interesting reminiscences of the great *savant*, which had been kindly furnished to Prof. Dewar by Sir Lyon Playfair. One of them, typical of Joule's enthusiasm for scientific work, will suffice:—"He once suggested to me," wrote Sir Lyon Playfair, "that we might take a trip together to the Falls of Niagara, not to look at its beauties, but to ascertain the difference of temperature of the water at the top and bottom of the fall. Of course the change of motion into heat was a necessary consequence of his views."

The suggestion put forth by Mr. Crompton at the last meeting of the Electrical Trades Committee that an association should be formed for the purpose of collecting, tabulating, and distributing useful electrical data, is without doubt a most excellent one; but, as Major Flood-Page remarked, while we all sympathise with the proposal, it is hardly possible to exaggerate the difficulty of attaining the end in view. Mr. Allen R. Foote, of Cincinnati, who is engaged on a similar task in the United States, reports somewhat ingenuously that "some managers of electric lighting and power stations have intimated to me that there are certain features of their business concerning which they do not desire to answer inquiries: they have acknowledged at the same time, however, that information regarding those very points, if given by *other* companies, would be more valuable to them than any other data that can be obtained." Precisely. We all subscribe to the maxim that the interest of the whole swarm is identical with that of the individual bee, but in such cases as the one in question the individual bee, while ready to drink—to quote the Chairman's words—from "the common fount of knowledge," has a rooted dislike to the necessary preliminary of contributing his particular drop of information to the common fount. However, the experiment is to be tried, and we wish it every success.

The experiments of Sarasin and Rive on multiple resonance in connection with electric oscillation seem to show conclusively that the phenomena discovered by Hertz are much more complex than has hitherto been supposed. It will be seen from the abstract which we publish that the electrical vibrations set up in a Hertz oscillator most probably consist of waves of many periods, just as the sound caused by striking a bell is composed of a multitude of tones differing in pitch. There appears nothing in this discovery which should cause surprise, although the experimental proof of it is most important. We cannot follow M. Cornu in thinking that Hertz's theory is much affected, for although it was assumed that the primary oscillator gave rise to an electric undulation of a single period determinable from its dimensions, yet this assumption is confessedly only made as a first approximation. The very fact that the simple method of calculation of the period of the primary vibrations is debateable, should prepare us to expect more complex undulations. Every analogy with

Digitized by Google

sound and light points, in fact, to the improbability of obtaining vibrations all of one period by any ordinary means. We believe Prof. LODGE has found in his experiments that there is no need for perfect resonance between the oscillator and resonator. This may arise from the same reason that a Helmholtz resonator will respond more or less to any note of about the same pitch as that to which it is tuned, although to the latter it will resonate best; but more probably it is due to the fact that the electric waves set up are of various periods. These experiments of SARASIN and RIVE, however, show the need of caution in deducing the velocity of light from HERTZ's experiments, and also serve to explain the discrepancies between some of the values obtained by HERTZ and the accepted velocity of light.

IT is sometimes good for us to have our fixed opinions directly challenged, and the letter which we publish this week from Prof. SCHUSTER, on the Counter Electromotive Force of the Arc, is a powerful argument against the common belief in the existence of a quantity the measurement of which has been the object of many researches. Our correspondent points out that, in order to obtain this quantity, we have to assume Ohm's law to be true for gases. We have either to assume that the resistance of the arc is independent of the strength of current, or that it increases uniformly with increase of length. These assumptions are no doubt unjustifiable save on experimental grounds. If, however, assuming this, the back E.M.F. is found to be fairly independent of current, there is strong experimental evidence not only for the truth of the assumptions, but also for the existence of the counter E.M.F. Should this not be found constant, we quite agree with Prof. SCHUSTER that the best way of publishing the results is simply as an experimental relationship between the applied E.M.F. and the current flowing.

SOME important tests of the efficiency of Westinghouse transformers, described in detail in the *Electrical World* of January 18th, have lately been made at the Massachusetts Institute of Technology by Mr. W. MARSHALL, under the direction of Prof. C. R. CROSS. The method employed was a calorimetric one, as the use of electrometers was considered unsatisfactory. The loss in the transformer was measured by an ice calorimeter, while a water calorimeter was used to measure the output. Each calorimeter was calibrated by passing a direct current through a German silver coil placed within. The experiments, which appear to have been made with great care, have yielded the result that the efficiency of the Westinghouse transformer lies between 93 and 94 per cent. It is, however, a great pity that tests were only made at full load. The absence of any system of storage with alternating currents makes it very desirable to know the energy absorbed by transformers working with little or no load. In practice, transformers are always joined to the mains, although they may be used for but a few hours a day; and what we need to know is the proportion which the energy given out during the working hours bears to the energy absorbed during the whole day.

As we announced in our last issue, the Brighton Corporation have decided by an overwhelming majority to follow the example of Bradford, and establish a municipal central lighting station on the low-tension system. The five resolutions moved by the Chairman of the Lighting Committee were not, however, passed without a discussion, distinguished alike for its great length and for the unusually thorough grasp of the subject which was shown by most of the speakers. The resolution relating to the price to be charged met with considerable opposition, and not without reason. At Bradford 5d. per unit, if we may judge from Alderman PRIESTMAN's recent remarks, has not as yet been found to pay: that being so, it is difficult to see how the 20 and 25 per cent. profit, which was hinted at by one speaker, is to be made out of 6d. per unit at Brighton, where coal is probably 30 per cent. or 40 per cent. dearer than at Bradford. Estimates of profits rarely err on the side of moderation, and it would be as well even for corporations to start by charging a price allowing a considerable margin for "accidents."

THE opposition of the American telephone companies to the use of the single trolley system of electric traction, to which our New York correspondent alluded in our last issue, has culminated at Cincinnati in a law-suit, which is exciting considerable interest all over the United States. The City and Suburban Telegraph Association, which operates the telephones in Cincinnati, has brought an action against the Mount Auburn Street Railway Company, with a view of compelling the latter to substitute the double for the single trolley system. The telephone company aver that up to the date of the introduction of electric traction their lines worked perfectly, but that since the advent of the single trolley the working of the telephone has been greatly impeded, and at times rendered impossible; and that, being the first in the field, they ought to have protection against this interference. The Street Railway Company, on the other hand, deny that they are responsible for these troubles, and assert that they have as good a right to use an earth return as their opponents. The question in dispute is, it will therefore be seen, one which affords ample scope for ingenious legal arguments. The telephone user (a perennial sufferer from the leakage and induction complaint) would no doubt be glad to see both parties obliged to use complete metallic circuits. Such a consummation is, however, perhaps out of the question; but we cannot help thinking that the disputants might be better employed in arriving at an amicable compromise than in wasting their substance on the gentlemen of the long robe. According to our New York correspondent, this has been done in several instances, the electric traction company agreeing to pay a certain proportion of the expense of changing the telephone service from a grounded to a metallic system.

AT the meeting of the Commissioners of Sewers on Tuesday last the electric lighting of the City was advanced another step by the adoption of the report of the Streets Committee recommending that a contract should be entered into with the Laing, Wharton, and Down Construction Syndicate for the lighting of

Digitized by Google

the Eastern division. Congratulations were exchanged on the advance which was being made.

As will be seen from an extract, which we print in another column, from the half-yearly report of the North Metropolitan Tramway Company, the working of the Barking-road section by the accumulator cars of the Electric Traction Company has given entire satisfaction, and we can but echo the hope of the North Metropolitan directors that Parliament will sanction the introduction of electric traction over that Company's entire system.

Cathedral Lighting.—The cathedral of Notre Dame at Montreal is now lighted by 400 incandescent and 15 arc lamps.

Sevenoaks.—At their last meeting the Local Board resolved to support the Provisional Order of the Electric Trust Company.

Obituary.—We regret to announce the death of Gustave-Adolphe Hirn, the eminent physicist, who died at Colmar on January 14th, in his 75th year.

Coventry.—At the last meeting of the Town Council it was resolved to oppose the Provisional Order promoted by the Midland House-to-House Electricity Company.

Leeds.—At the special meeting of the Leeds County Council held on Tuesday the recommendation of the Joint Committees, referred to in our last issue, was agreed to by 25 votes to 18.

Joule International Memorial.—Subscriptions to the Joule International Memorial Fund should be sent to the Hon. Secretary, International Joule Memorial Committee, Royal Society, W.

Proposed International Exhibition in New York. — *The Times* states that both the New York Assembly and the New York Senate have passed Bills authorising the proposed World's Fair in 1892.

St. Luke's Vestry.—At the last meeting of this Vestry it was decided to offer no opposition to the proposed Provisional Orders of the London Electric Supply Corporation and Brush Electrical Engineering Company.

Edinburgh Exhibition.—At the last meeting of the Executive Committee the question of the applications for space was considered, and it was resolved to recommend that considerable addition should be made to the buildings.

The Electric Light at the Public Record Office.—The electric light, which has recently been introduced in the Public Record Office, is now in working order, the public search rooms and corridors being lighted by 110 incandescent lamps.

Personal.—Mr. J. E. H. Gordon, engineer to the Metropolitan Electric Supply Company, has been appoined consulting engineer to the Westminster Electric Supply Corporation, who are about to erect four central stations in the Westminster district.

Western Union Telegraph Company.—The Western Union Telegraph Company announce that two submarine cables have now been completed between Nova Scotia and New York, establishing direct cable communication from England into their office at 16, Broad-street, New York City.

Hanover.—Owing to the favourable report of Prof. F. W. Kohlrausch, the Town Council of Hanover has voted 1,500,000 marks for the erection of a 15,000-light central station. They have accepted the offer of Messrs. Schuckert and Co., who will use the three-wire system in conjunction with accumulators.

Electric Traction in Germany.—From the *Elektrotechnisches Echo* we learn that the metre gauge line at Hildburghausen-Heldburg will be worked by electricity by Messrs. Hostmann and Co. In the event of this line proving successful, Messrs. Hostmann and Co. will also work the tramway from Weimar to Gera by electricity.

Accident at the Sardinia-street Station.—Early on Wednesday morning the cover of the "blow-off" of one of the boilers at the Sardinia-street Central Lighting Station, which was not properly secured, was blown from its place into the roof of the building. A man employed on the premises was knocked down, and received some injury.

Edinburgh.—Objections have been lodged with the Board of Trade by the Corporation and the Gas Commissioners against the electric lighting applications. The Corporation state that they have never shown a disinclination to use the best available means of public lighting, and have already indicated their intention to apply for electric lighting powers.

Brighton.—Last week's gale severely affected the electric line constructed by Mr. Magnus Volk. Along the Madeira-road about 150 yards of the track has been demolished, owing to the sea washing away the shingle upon which the track is laid. The stopping station opposite the Aquarium was also at one time in great danger of being carried away by the waves.

Telegraphic Breakdown in Lewis.—Great inconvenience, says the *North British Daily Mail*, continues to be felt at Stornoway through the breaking of the telegraph cable, and it is feared that some time may elapse before the fracture is repaired. The cable steamer "Monarch," which had been despatched to repair the cable, was forced, owing to the severity of the weather, to take shelter in Falmouth.

The Action of Lightning upon Gas and Water Pipes.—The *Elektrotechnisches Verein* of Berlin, which is investigating the action of lightning upon gas and water pipes, has issued a request that as many cases as possible of damage so caused, or instances of the effect produced, be described to them. Communications to be addressed to Prof. Dr. von Bezold, im Königlichen Meteorologischen Institut, Berlin W., Schinkelplatz, No. 6.

The Proposed Canadian Cable.—A Bill has been introduced into the Canadian Parliament to charter a Canada Cable Company for a new cable from Ireland to some point on the north shore of the Gulf of St. Lawrence, where connection will be made with the land lines. The Canadian Pacific Railway Company's telegraph lines were completed on Monday last to Halifax, and there is now direct communication by their wires from the Atlantic to the Pacific coast.

Barnsley.—The Barnsley Gas Company have given notice of their intention to terminate the contract for lighting public lamps with gas at the end of June, and the Lighting Committee have recommended the Town Council to invite the electric lighting companies to state on what terms they would establish plant to supply electric light both for public and private purposes within the borough, in accordance with provisions expected to be obtained by Provisional Order.

Bournemouth.—At the last meeting of the Improvement Commissioners it was asked whether any steps had been taken to test the safety of the overhead wires connected with the electric light?—The Clerk said that the Commissioners had represented to the Board of Trade that there were overhead wires in the town, and had asked the Board of Trade to make regulations in respect thereof.—A member of the Committee of Commissioners said that the Committee were unanimous in their opposition to overhead wires.

Beckenham.—At a meeting of the Beckenham Local Board on Monday, the Clerk presented a report upon the proposal of the Electric Construction and Maintenance Company to apply for a Provisional Order, and recommended that the Board inform the Board of Trade that although the consent of the Beckenham Board had not been applied for, they would not withhold consent, provided there was inserted in the Provisional Order a clause giving them the option of purchase of the undertaking at the end of ten years, on terms of 33 per cent. premium.

Dundee.—Another joint meeting of the Town Council and Police Commission in regard to the question of electric lighting was held last week. It was resolved to ask the Gas Commissioners to agree to the reconstruction of their Board on a popular basis, and at their own instance to promote the Provisional Order. The Gas Commission, which met subsequently, unanimously adopted this proposal, and also instructed the clerk to lodge objections against the application for a Provisional

Digitized by Google

Order lodged by the Scottish House-to-House Electricity Company.

Exhibition of Meteorological Instruments.—The Council of the Royal Meteorological Society have arranged to hold, at 25, Great George-street, Westminster, on March 18th to 21st next, an Exhibition of instruments and photographs illustrating the application of photography to meteorology. The Council are anxious to obtain as large a collection as possible of such instruments, and will also be glad to show any new meteorological instruments or apparatus invented, or first constructed, since last March, as well as photographs and drawings possessing meteorological interest.

Bolton.—A special meeting of the Bolton Town Council was held on Saturday last to consider the position of the Corporation in relation to the Provisional Order promoted by the House-to-House Electricity Company. After a long discussion, resolutions were passed unanimously to oppose the measure of the company named, and authorising the Corporation to apply for the requisite powers to supply electricity within the borough. In the discussion it was stated that the putting down of the necessary plant for the supply of electricity would entail an expenditure of from £50,000 to £60,000.

Bristol.—At a meeting last week of the Electrical Committee of the Town Council, the question of introducing the electric light was again under consideration. It was reported that a carefully-prepared estimate for lighting a certain portion of the town had been received from Mr. Preece. It was agreed that the document should be printed, and that another meeting should be held at an early date to take it into consideration. Meanwhile the Committee will advise the Council to oppose the granting of Provisional Orders to the House-to-House Company and the Brush Electrical Engineering Company.

Telephonic Communication in Holland.—In the course of the month the Dutch Bell Telephone Company, says *Industries*, will give a great extension to their system in different provinces by laying special new lines between Amsterdam and Haarlem, Amsterdam and Zaandam, Rotterdam and Dordrecht, &c., in accordance with the Government regulations regarding their construction. After the completion of these supplementary lines, towns not hitherto in telephonic communication will be brought into direct contact, and Dordrecht will be able to converse with Haarlem, and Zaandam with Rotterdam and the Hague. The uniform charge for the use of these telephones is to be 50 Dutch cents, or 10d., for three minutes' talk on the instrument.

Bamberg.—According to the *Elektrotechnische Echo*, the introduction of the electric light at Bamberg has resulted in serious difficulties with the telephone. So long as the lighting current is on, communication with Nürmberg is impossible. Experiments have been made, the results of which tend to show that the disturbances are principally due to earth leakage. All attempts to overcome the noise in the telephone wires have been without success. It is believed by some that the difficulty can be traced to two six-pole machines at the waterworks, as the noise is not discernible when the two, four, and eight-pole machines only are running. The Electric Light Company has therefore agreed to build other dynamos in five weeks; meanwhile the supply of current is suspended.

Australasian Telegraph Statistics.—The miles of telegraph line in Victoria amount to 4,194, representing 10,360 miles of wire, the business of transmission of messages being divided between 595 stations, a greater number than exist in any other Australasian Colony; New Zealand coming next with 473 stations; New South Wales, 460 stations; Queensland, 311; South Australia, 211; Tasmania, 124; Western Australia, 38. In the matter of mileage, New South Wales heads the list with 10,690 miles of line and 22,219 miles of wire; Queensland has 9,166 miles of line and 16,648 miles of wire; South Australia, 5,436 line and 9,775 wire; New Zealand, 4,790 line and 11,617 wire; then Victoria, 4,194 line and 10,360 wire; Western Australia, 2,961 line and 3,234 wire; Tasmania, 1,245 line and 1,848 wire.

The Electric Lighting of the British Museum.—On Tuesday night the trustees of the British Museum invited a large party to a private view of the lighting of the galleries by the electric light. The installation now comprises 137 arc lamps and 827 incandescent lamps. The current is generated by four Siemens dynamos, each capable of giving 450 amperes and 130 volts. The four dynamos are driven in pairs, each pair by a separate engine with a separate counter-shaft. Each engine has a separate steampipe in direct communication with the boilers, and there is an ample reserve of boiler-power. Each of the two sets is capable of working the whole of the lamps in those galleries proposed to be lighted on any one evening. The steam-engines have been supplied by Messrs. Marshall, Sons, and Co., of Gainsborough, and the electrical work has been executed by Messrs. Siemens Brothers and Co. The installation has been carried out under the supervision of Mr. W. H. Preece, F.R.S.

Private Bills in Parliament.—Mr. Campion, the Examiner of Private Bills, has had the following Bills under consideration and found compliance with the Standing Orders of Parliament in each case:—The North Metropolitan Tramways Bill (promoted for the purpose of authorising the use of electricity as a motive power on the system of tramways worked by the company; powers are also sought to raise additional capital not exceeding £100,000 in shares of not less than the nominal value of £10). The Aberdeen Electric Lighting Bill (to authorise the Corporation of Aberdeen to erect and maintain electric lines and works, and to supply electrical energy within the city and burgh of Aberdeen; power is also sought to borrow £50,000, to be secured on the mortgage of the undertaking and of the gas undertaking; in the case of charging consumers for the actual quantity of energy supplied the following is the schedule of charges per quarter: for any quantity up to 100 units £3 10s., and 8d. for each unit over 100).

Electric Traction on the North Metropolitan Company's Lines.—The following is an extract from the half-yearly report of the North Metropolitan Tramway Company, to be submitted to their shareholders on February 5th:—"As mentioned in a previous report, an arrangement was entered into with the Electric Traction Company for working the company's cars on the Barking-road section, and the directors are glad to state that the results during the half-year have been satisfactory. The electric cars have run 34,366 miles, and have carried 469,095 passengers. The cost to this company for electric traction has been 4½d. per mile run (including the wages of drivers), which is less than the average cost per mile run for horse traction over the entire system. The Barking-road section is a short single line with loops, requiring only a low mileage, with a small number of cars, which does not offer such facilities for economic working as a longer line would, with a higher mileage and more cars worked by a larger installation; but the result of the working of electric cars on the Barking-road justifies the directors in hoping that Parliament will sanction the introduction of electric power over the company's system, and enable them to extend its application to other lines."

Alteration in the Conductivity of Various Metals after a Lengthened Exposure to a High Temperature.—The alterations in the conductivity of pure copper, aluminium and magnesium, and of commercial zinc and German silver, after a lengthened exposure to a high temperature, have recently been investigated by J. Bergmann. Discs, 70mm. in diameter, were heated to 300°C., and maintained at that temperature for one hour, and then allowed to slowly cool. The conductivity of the copper was increased by something like 2·4 per cent. by this process, that of aluminium, magnesium, and zinc, being increased respectively by 5, 6·8, and 2·4 per cent. The conductivity of the alloy was, on the other hand, diminished by about ·2 per cent. These results are somewhat similar to those obtained for iron by Mr. Tomlinson, and which were set forth in his Paper on "The Effect of Repeated Heating and Cooling on the Electrical Resistance of Iron," read recently before the Physical Society of London (*The Electrician*, November 29, 1889). Mr. Tomlinson, after successively heating a specimen of iron wire several times to 100°C. and allowing it to cool, found that the specific resistance at 17°C. had diminished from 11,162 to 10,688 C.-G.-S. units, a decrease of about ·25 per cent.

Digitized by Google

Reading.—At the last meeting of the Town Council an animated discussion took place on a report by Major Cardew, and on a proposal by the Lighting Committee that the Laing, Wharton, and Down Construction Syndicate should be requested to alter the position of their wires, so as to make them cross the streets as nearly as possible at right angles. Major Cardew reported that the work was well and strongly done, but no special attention had been paid to the safety of the public. Several of the wires crossed telephone wires without precautions against contact, suspending wires were not used, and a few of the spans exceeded the regulation length. Mr. Monck opposed the proposal to call upon the Syndicate to rearrange their wires, on the ground that every wire had been put up in its present position by the consent of the Council. If they did not like the agreement with the Syndicate let them say so boldly, and not throw, as they had been doing for the past three months, every possible hindrance in the way of it. The recommendation of the Committee was adopted. At a later stage of the same meeting it was determined to oppose the applications for a licence of the Laing, Wharton, and Down Construction Syndicate, and of the Brush Electrical Engineering Company and the South of England House-to-House Electricity Company for Provisional Orders, on the ground that the Council intends itself next Session to apply for a Provisional Order.

The Cincinnati Inclined Plane Electric Railway.—One of the electric railways which is attracting a great deal of attention among American street railway men is the Cincinnati Inclined Plane Electric Railway, the equipment of which was furnished by the Sprague Company. One terminus of the road is in the centre of the city. The electric cars run to the base of an incline, to the top of which they are carried upon an elevator. Upon leaving the elevator the cars again make connection with the overhead wires, and the line extends to the Zoological Gardens, about six miles out from the city. The dynamos are of the standard Edison type for railway circuits, and they have now been in operation for seven weeks without re-oiling. The self-oiling bearings upon these dynamos are of the now well-known ring pattern, in which the oil is distributed over the interior of the bearings automatically by the revolution of the shaft, and after performing its duty of lubrication is returned to the reservoir, where it has opportunity to cool and settle. The two pints of oil which were placed in the dynamo bearings at the starting of the road have not been added to, and the dynamos have since run without any attention whatever. The grades upon this line are very heavy, reaching in some cases as high as 12½ per cent. The amount of coal consumed per day is about 3½ tons of nut and slack for 17 cars, or an average of one-fifth of a ton per day per car. The steam power required for the operation of these 17 cars is supplied by one 150 horse-power engine.

Launch of the Twin-Screw Cable Steamer "Relay."—On Thursday last week there was successfully launched from the yard of Messrs. R. Thompson and Sons, Southwick, a steel twin screw steamer, designed for submarine cable work, built to the order of J. R. France, Esq., of 11, Queen Victoria-street, and destined for the service on the cables of the Central and South American Telegraph Company, of New York. Her dimensions are—length 240ft., breadth 32ft. 2in., depth of hold to Lloyd's ordinary floors 24ft. She is built on the cellular bottom principle, divided into fore and aft and thwartship divisions, so that she can be readily trimmed when laying cable. There are also three tanks for holding the cable, besides the usual appliances of merchant ships. On the bow and stern are large sheaves for paying out and hauling in the cables. On the main deck there will be fitted a combined picking-up and paying-out machine, by Messrs. Johnson and Phillips, driven by a pair of powerful independent engines. The vessel is fitted with two steam winches, large multitubular donkey boiler, steam steering gear, steam windlass, and steam sounding machine, and all the latest improvements. The boats are fitted with patent disengaging gear and patent sheaves for paying out and taking in cables. The engines have been constructed by Messrs. G. Clark (Limited), Southwick: they are of 180 N.H.P. The vessel being very finely modelled, a high rate of speed will be attained. During their construction the steamer and engines have been under the inspection of Mr. D. Rosser, of Cardiff.

London County Council.—At the meeting of the Council last week the Highways Committee recommended that notice should be given to the Metropolitan and the House-to-House Electric Lighting Companies, to desist from carrying out works which have not received the sanction of the Council, and further that the House-to-House Company be required to remove the iron covers already laid down, and to substitute others of the description specified in the Council's notice of sanction of the company's works. The recommendations were adopted.—At the meeting of the Council on Tuesday the Highways Committee reported that they had considered the 23 Provisional Orders for which application had been made to the Board of Trade and the three Bills to be introduced into Parliament next Session relating to electric lighting schemes. They recommended, amongst other things, that all the Provisional Orders and Bills should be amended so as to make them accord with the legislation in respect of electric lighting; that Provisional Orders and Bills comprising areas for which Parliamentary powers had already been conferred upon more than one company be opposed; that in respect of Provisional Orders and Bills relating to the City, the Council should seek for the same powers as were conferred upon it by the Orders and Act of last year; and that the following Orders and Bills be objected to: St. Martin-in-the-Fields and Strand Electric Supply Order, Strand Electric Lighting Bill, St. Martin-in-the-Fields Electric Lighting Bill, St. Pancras Electric Light Supply Order. The recommendations were agreed to.

Folkestone.—At the meeting of the Town Council on Friday last, the Town Clerk read a report from Mr. Preece on the copy of the proposed Provisional Order and draft contract between Messrs. Crompton and the Corporation, which had been sent to him for the purpose. The following is a brief abstract of this document, which we take from the *Folkestone News* of 25th instant:—"Not being acquainted with the history of the transaction with Messrs. Crompton, I am not aware of the reasons, if any, why the Provisional Order is taken out by Messrs. Crompton. It appears to me that the natural course would have been for the Order to have been taken out by the Corporation, and that the provisions of that Order should have been sublet by agreement to Messrs. Crompton as contractors to the undertakers. Messrs. Crompton and Co. are a limited company of very high standing and unimpeachable reputation, but they are also a firm of manufacturers with a limited capital, quite insufficient to carry on their own business and enter into many contracts such as that proposed to be entered into with the Corporation of Folkestone without enlarged financial powers. It is apparently a species of speculation on the part of Messrs. Crompton and Co., which means that the provisions of the Order and of the contract must be ultimately transferred (for a consideration) to some local or other company. The price at which Messrs. Crompton propose to supply public lighting (£24 per lamp per annum) is very fair and reasonable, while that which they propose to charge for private lighting (1s. 4½d per unit) is excessive and absurd." Mr. Preece then criticises the clauses of the draft contract in detail. "Clause 4.—It is proposed to fix the additional lamps at distances not greater than 400 feet apart. The lamps should not be fixed at a greater distance apart than 300 feet. Greater distances will lead to disappointment. Clause 5.—If the Corporation allow the erection of overhead wires—and I know no reason why they should not, for the alarm of danger that has sprung from exaggerated and untruthful accounts of accidents in New York is groundless—then these wires must be erected in accordance with the rules and regulations of the Board of Trade, which expressly exclude *bare* copper wires." In conclusion, Mr. Preece, after suggesting several alternatives, advised the Corporation to oppose the granting of a Provisional Order to Messrs. Crompton, but to apply for a licence, and to complete the agreement with Messrs. Crompton and Co. A resolution was subsequently carried by a large majority, substantially embodying Mr. Preece's recommendations.

Digitized by Google

MAGNETISM IN IRON AND OTHER METALS.*

BY PROF. J. A. EWING, F.R.S.

IV.

(*Continued from page 260.*)

§ 20. Connection of the Ideas of Permeability and Susceptibility.—We have seen (§ 13) that

$$\mathbf{B} = 4\pi\mathbf{I} + \mathbf{H};$$

and by definition of the susceptibity κ, $\mathbf{I} = \kappa\mathbf{H}$;

$$\text{Hence } \mathbf{B} = 4\pi\kappa\mathbf{H} + \mathbf{H}$$
$$= (4\pi\kappa + 1)\mathbf{H}.$$

But by definition of the permeability μ, $\mathbf{B} = \mu\mathbf{H}$;

$$\text{Hence } \mu = 4\pi\kappa + 1,$$

$$\text{and } \kappa = \frac{\mu - 1}{4\pi}.$$

In a substance such as air, in which the permeability is unity, the magnetic susceptibility is zero. In a paramagnetic substance, in which μ is greater than 1, the susceptibility is positive. In a diamagnetic substance, in which the permeability is less than 1, the susceptibility is negative.

In other words, a paramagnetic substance when subjected to magnetic force acquires a magnetisation **I**, which is in the same direction as the force, and so makes **B** greater than **H**. A diamagnetic, on the other hand, acquires a magnetisation **I**, which is opposite to the force, and so makes **B** less than **H**.

§ 21. A word of caution is, perhaps, desirable here as to the application of the equations which have just been given. It has been assumed that the material to which the magnetic force **H** has been applied, has no magnetism except what the force itself induces. If other forces had acted before, leaving residual magnetisation, the ratio $\frac{\mathbf{B}}{\mathbf{H}}$ would not be a true measure of the permeability, nor would the ratio $\frac{\mathbf{I}}{\mathbf{H}}$ be a true measure of the susceptibility.

Again, it has been assumed that the material is magnetically isotropic—that is to say, that a lump of it is equally capable of taking magnetisation in all directions. If this were not so, if the magnetic properties of the substance were different in different directions (as would, for instance, be the case to some extent in a piece of iron cut from a rolled plate), it would be necessary, if we wished to specify fully the relation of the magnetisation to the magnetic force, to resolve the force into components along axes chosen in the directions which give greatest susceptibility and least susceptibility, find the component magnetisation in each of those directions by multiplying each component force by the value which the susceptibility has in that direction, and then compound these components of magnetisation to find the resultant value of **I**. In such a case the direction of the resultant magnetisation will not in general coincide with that of the resultant magnetic force, and the equation $\mathbf{B} = 4\pi\mathbf{I} + \mathbf{H}$ will be true only when interpreted in its vector sense.

But in the cases of magnetisation in iron which have ordinarily to be dealt with, it is not necessary to take account of this consideration, for the material is either sufficiently nearly isotropic, or the direction of the applied magnetic force coincides with an axis of greatest or least magnetic susceptibility, and the effect is that **I** and **B** have the same direction as **H**.

§ 22. Influence of the Form of Bodies on the Magnetisation induced in them.—When a body is placed in a magnetic field the degree to which it becomes magnetised depends not only on the original strength of the field and on the permeability of the substance, it depends also (often in very great measure) on the form of the body. This is because the body, in becoming magnetised, generally disturbs the field, causing the magnetic force at any point within or near the body to be different from the force that existed there before the body was introduced. The free magnetism which is developed by the body's magnetisation contributes to produce magnetic force, and so affects the resultant value of the force at any point, inside the body or outside, that is not too far off to be sensibly affected. With iron and other very susceptible materials this disturbance of the field is often so great that the original value of the magnetic force is not even a rough approximation to the value the force assumes when modified by the magnetisation of the body. The intensity of magnetisation at any point within the body depends on the actual value which the magnetic force assumes at that point, and this in its turn depends partly upon the magnetisation of the body as a whole. When we wish to examine the magnetic susceptibility or permeability of a substance, we require to know the actual value of the magnetic force within it, for the purpose of comparing that with the intensity of magnetisation, or with the magnetic induction there. The permeability is measured by the proportion which the induction **B** bears to the strength which the magnetic force **H** actually has at the same place, not to the strength which it may have had there before the body was introduced, nor to the strength which it may still have in external parts of the field.

We have, therefore, to take account of what may be called the reaction of the magnetised body upon the magnetising field.

In very many cases the reaction of the body upon the field is too complex to allow a mathematical examination of it to be practicable. With bodies of irregular form it is out of the question to calculate beforehand what will be the magnetic force and the magnetic induction at internal points, having given the original strength of the external field and the permeability of the substance. The problem is determinate, but too difficult to attack. Even so apparently simple a case as that of a short cylindrical iron rod with flat ends, placed lengthwise in an originally uniform field, presents difficulties so formidable that no exact solution has been given. The difficulty in the case of such a rod is aggravated by the fact that even though the rod be perfectly homogeneous to begin with, the susceptibility or the permeability is not uniform throughout when the rod becomes magnetised. This is because the magnetisation is not uniform, and, as we shall see later, the permeability of iron depends to a considerable extent on the intensity of magnetisation. The reaction of the rod upon the original field tends to reduce the magnetic force at internal points, but this effect is unequal at different parts of the length. It is least at the middle of the length; hence the magnetic force, and consequently the induction also, is greatest there and is less near the ends.

§ 23. Long Rod placed Lengthwise in a Uniform Field.—When the rod is long in comparison with its breadth and thickness the effect of its free magnetism in reducing the magnetic force is less than when the rod is short, especially in the middle region of the length, because the ends, in which the free magnetism chiefly resides, are too far off to have much influence. The amount of magnetic induction is consequently greater in a long rod than in a short one of the same breadth and thickness, the original strength of the field and the permeability of the substance being the same in both cases. When a very long rod is placed lengthwise in a uniform field the influence of the ends becomes almost insensible, and the actual magnetic force at points within the rod is then almost the same as at points outside, except near the ends. The magnetisation will be practically uniform throughout the middle region, but will fall off towards the ends.

When the substance of the rod is very permeable, the rod must be very long relatively to its transverse dimensions before we may neglect its reaction upon the magnetic field, and before we may treat the magnetic force at internal points near the middle as sensibly equal to the force at external points, and the magnetisation as nearly uniform. When the substance is less permeable a shorter length will give an equally good approach to uniform force and uniform magnetisation.

§ 24. Analogy of Induced Magnetisation to Electric Conduction.—The concentration of magnetic induction which takes place when a permeable body is placed in a magnetic field is analogous to the concentration of electric flow which may be

* All rights are reserved.

Digitized by Google

brought about by immersing a piece of copper in a tube full of mercury, through which an electric current is passing. Let the tube be wide and long, and let the current in it be uniformly distributed over the whole cross-section: we have in this the analogue of a uniform magnetic field. Suppose a short piece of copper wire to be inserted and held lengthwise anywhere near the axis of tube. The lines of electric flow, which before were straight and parallel, converge more or less towards the piece of copper, preferring to crowd into it, because its conductivity is much greater than that of the surrounding medium. The whole current is divided between the copper and the mercury around it, the copper taking a share that is greater than the proportion which its cross-section bears to that of the whole conducting tube. The current enters and leaves the copper not at the ends merely, but also along the sides, especially near the ends. If the piece of copper is short, there can be no more than a slight convergence of the flow into it. For instance, to take an extreme case, a little disc of thin copper plate placed in the mercury, so that it faces in the direction of the flow, has little more conduction through it than through an equal area of the surrounding liquid. In other words, the disc produces but a slight disturbance of the distribution of flow in the tube. On the other hand, a long thin copper wire set lengthwise will gather much of the flow into itself, and if the wire be very long its share of the whole will be greater than the amount taken by an equal section of the mercury in the proportion in which the conductivity of copper is greater than that of mercury. Substitute magnetic permeability for electric conductivity, and magnetic induction for electric flow, and we have a nearly perfect analogue of what happens when an iron rod or wire is placed in a magnetic field.

There is, however, this important difference, which makes the magnetic case less simple than the other. The electric conductivity of the copper is a constant quantity, independent of the strength of current in the metal; whereas the permeability of iron depends on the actual intensity of magnetisation, and consequently varies (in general) to some extent throughout the piece.

§ 25. **Cases in which the Magnetisation is Uniform: Ellipsoid.**—In certain special cases it happens that when a magnetisable body is placed in a uniform magnetic field, the magnetic force at all points inside the body is uniform, though its value there is not the same as at external points. A very important instance in which this is true occurs when the form of the body is that of an ellipsoid, the material being homogeneous, so that the permeability has the same value throughout. In such a case it may be shown that the effect of an originally uniform external field is to produce a strictly uniform magnetisation.*

Let the ellipsoidal body be made of a paramagnetic material, such as iron, and let it be placed in a uniform field: then the originally straight and parallel lines of the field become bent, so that they converge on it, as the lines converge on the sphere in Fig 5. The reaction of the body on the field is such that the magnetic force at outside points near the body is no longer uniform. But at internal points the effect of the reaction is different. The force becomes uniform there, with a value, however, which is less than the value it had in the undisturbed field. This uniform internal force implies uniform induction and uniform intensity of magnetisation—that is to say, each of the quantities **H** and **I** and **B** is uniform throughout the whole of the body; but it must be borne in mind that **H** differs, and often differs greatly, from the value which the force had originally, and still has in distant parts of the field. The amount of this difference will depend on the shortness of the ellipsoid and the intensity of its magnetisation. For brevity we shall use **H′** to designate what may be called the external force—that is, the original value which the force had before the field was disturbed, or, what is the same thing, the value which the force still has at distant external points; and we shall keep **H** to mean, as usual, the actual magnetic force at points within the metal.

§ 26. **Magnetisation of an Ellipsoid** (*continued*).—The case of an ellipsoid subjected to the action of an originally uniform field is of so much practical interest that it is worth while to state here some of the results of calculation which are applicable to it.

Suppose the ellipsoid to be set with one of its axes pointing in the direction of the magnetic force. Let c be half the length of this axis, and a and b half the lengths of the other axes, which point in directions that are perpendicular to the direction of the force. It will suffice to take the case of an ellipsoid of revolution, in which $a = b$.

The original external force being **H′** and the force actually operative being **H**, we have

$$\mathbf{H} = \mathbf{H}' - \mathbf{N}\,\mathbf{I},$$

where **N** is a number depending on the relation of the length of the ellipsoid to its transverse dimensions. We may express **N** in terms of the eccentricity e. When the ellipsoid

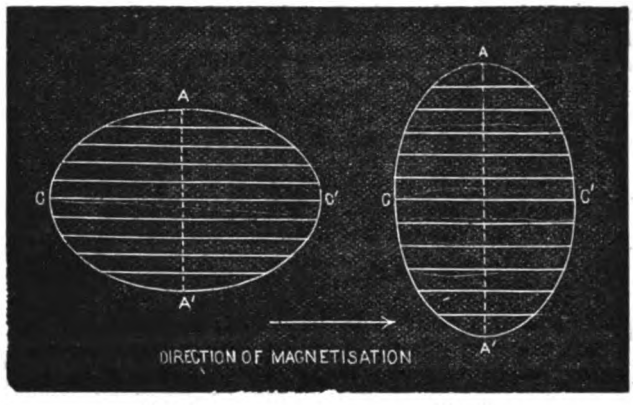


Fig. 7. Fig. 8.

is of the prolate or elongated form, Fig. 7 (the polar diameter $2c$ or CC' greater than the equatorial diameter $2a$ or AA'), $e = \sqrt{1 - \frac{a^2}{c^2}}$, and

$$\mathbf{N} = 4\pi\left(\frac{1}{e^2} - 1\right)\left(\frac{1}{2e}\log_e \frac{1+e}{1-e} - 1\right) \quad . \quad . \quad (1)$$

When the ellipsoid is much elongated this expression approximates to the following simpler form:—

$$\mathbf{N} = 4\pi\frac{a^2}{c^2}\left(\log_e \frac{2c}{a} - 1\right) \quad . \quad . \quad . \quad . \quad (2)$$

When the ellipsoid is of the oblate or flattened form, Fig. 8 (the polar diameter $2c$ less than the equatorial diameter $2a$), the eccentricity e is $\sqrt{1 - \frac{c^2}{a^2}}$, and

$$\mathbf{N} = 4\pi\left(\frac{1}{e^2} - \frac{\sqrt{1-e^2}}{e^3}\sin^{-1}e\right) \quad . \quad . \quad . \quad (3)$$

(To be continued.)

* *See* Maxwell's "Electricity," Vol. II., §§ 437-438.

UNDERGROUND MAINS.

BY G. L. ADDENBROOKE.

III.

(*Continued from page 287.*)

Having in the first two articles touched briefly on earlier experiences on the forms of conduits used in telegraphic work, and the lasting qualities of some of the principal material employed, it is proposed now to pass on to systems at present in use for electric lighting.

The Edison Company's System.

This, the oldest of the complete systems of underground mains worked out commercially in all its details, is now usually laid down in the following manner:—

The system naturally divides itself into three parts—the feeders, the mains, and the branches. All these are made on the

Digitized by Google

principle of placing—for the three-wire system—three copper rods lapped round with yarn in wrought-iron tubes; the yarn keeps the rods at the proper distance apart, and the tube is entirely filled with a bituminous insulating compound, beyond which the conductors project a few inches at each end. These tubes are made in lengths of 20ft. 6in. For the feeders the neutral wire is about half the size of the positive and negative conductors; for the mains all three conductors are usually of the same size; the feeders, besides the three rods, have pilot wires inserted in them, one for each conductor. These lengths of tubing are laid in the roadway about two feet deep, and are usually protected from injury by a stout plank laid above them. The conductors in each length of tubing are joined to those in the next length by short pieces of flexible stranded cable, having solid metal sleeves sweated on each end, as shown in the sketch (Fig. 1). These couplings are arranged to bear everywhere the full section of the rods they connect; the hollow portion of the connecting piece or sleeve is slipped over the copper rod, which it fits, and is then very carefully soldered to it. The same form of coupling is used throughout.

Fig. 1.—Flexible Copper Connecting Piece employed by the Edison Company.

To join one section of the piping to the next, and for taking off branches, junction boxes are used. The sketch (Fig. 2) gives a general idea of one in which a branch is taken off. For the three connections the boxes are made in a similar way, but without the arrangement for taking off the branch. A short distance from the end of each pipe, coming into the box, two iron castings which fit the pipe are clamped together. The two portions of these castings which are nearest the box are hemispherical in shape outside, and form together one portion of a ball-and-socket-joint; the junction box has hemispherical hollows at each place where the pipes enter it, which fit closely over the balls, so that a ball-and-socket-joint is formed with a limited range, allowing the tubes to be set at more or less of an angle with each other. When the couplings have been made in a box the top half is

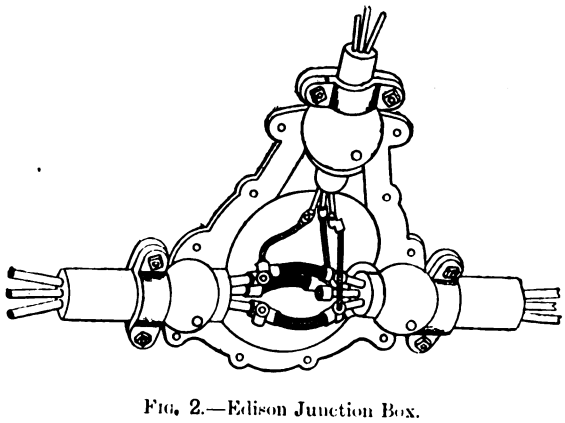


Fig. 2.—Edison Junction Box.

screwed on, and the whole is run full of a hot insulating compound, which solidifies on getting cool. Elbow boxes are used for getting round corners. The tubes are made of different sizes to hold copper conductors varying in diameter from $\frac{3}{4}$in. to $\frac{1}{4}$in., and the junction boxes are also made so that a through box can be replaced by a box for taking off a branch at any joint. Manholes are provided at different places over the system into which the tubes are brought, and where cut-outs are placed and different portions of the network of conductors joined together, it being as far as possible usual to connect each portion of the mains so that they will be supplied from more than one feeder.

For feeders in large stations, where the section of copper required is very great, the Edison Company do not confine themselves to the use of this form of construction, but frequently lay down a number of iron tubes in concrete and parallel to each other, into each of which pipes an insulated cable is drawn. This method admits of more copper being got into the same space than the former one, as the junction boxes take up a good deal of room, and prevent the tubes holding the conductor from lying very close to each other.

This system may at first sight look rather cumbrous and expensive, but it is made of cheap material, while the work itself is of a sound and substantial character, likely, if well laid down, to last indefinitely. As it has been very largely used in America by the Edison Company now for several years, they have been able to perfect the details and eliminate weak points from actual experience.

Other American Systems.

In several of the leading towns something has been done towards getting a portion of the telephone wires put under ground, for which bitumen or wood conduits have been largely used, the cables being lead covered. As far as electric light mains are concerned, at the last year's meeting of the American National Electric Light Association a committee reported that they had sent circulars to all the local companies on this subject. Out of 130 answers only seven of the companies sending them appear to have had experience of underground wires, and none of these are enthusiastic on the subject. It must be pointed out that this related to high-tension current work for arc lighting, the average tension being 1,893 volts, and the current 10 amperes. For alternating-current house-to-house distribution but little underground work has been used in America so far. Where conduits are made use of, there is usually an overhead network in connection with them for local services. In Chicago a good deal of work has been done in the sewers, okonite lead-covered cable being successfully used: this is supplemented by a system of iron pipes and man-holes much like that in New York. In the eastern cities several systems have been more or less tentatively tried, but the general consensus of opinion appears to be in favour of the method of construction adopted, after many trials, by the Board of Electrical Control in New York, and which is as follows:—

The Iron Pipe and Man-Hole System.

Cast-iron socket-pipes three or four inches in diameter are laid between large man-holes. In places where there are many

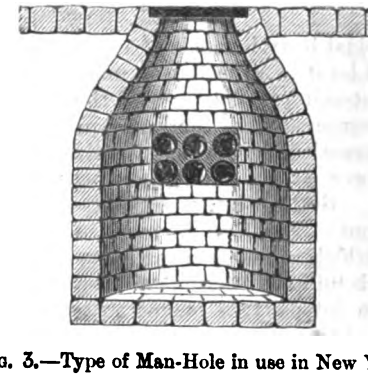


Fig. 3.—Type of Man-Hole in use in New York

cables, several lines of piping are laid parallel to each other, concrete being employed to keep the lines straight and in their places. These lines of piping, as well as the man-holes, are usually placed in the roadway. The man-holes are placed at varying distances apart, according as the district is a busy one or not. They are much deeper, larger, and more important than those generally used in European work, it being intended to radiate the cables for local services from them, no provision being made for tapping the pipes between. It is, however, probable that some alteration will take place in this respect before long. Fig. 3 shows the general construction of the man-holes. They are about 8ft. deep and 4ft. across

Digitized by Google

at the bottom. The pipes are shown coming in about half way up. Local connections are taken off nearer the surface. If the man-hole is at the corner of two streets there may be several sets of pipes coming into it in different directions. The man-holes are large enough for a man to stand inside to do jointing work or pulling through; they are closed at the top by a circular iron lid fitting into a suitable casting to receive it. Naturally in places water accumulates in the bottom, and has to be pumped out before the man-hole can be entered; but as there is so large a space inside, and the cables are some distance up, they will usually be out of its reach. Lead-covered cables having 7/16 stranded cores are generally employed, and regular plumber's joints are made on the lead covering when connecting two pieces together.

The Siemens System.

This system, which has been worked out by Messrs. Siemens Bros. and Halske, of Berlin, is one which makes a bold bid to solve the problems both of cheap construction of the cable itself and the cheap placing of mains underground, not only for currents at low tension, but for alternating high-tension currents a'so. For these two purposes cables constructed of the same materials, but differently arranged, are made: for low-tensions the cables are of the ordinary character; for high-tensions the cables are concentric, one set of wires being outside of and surrounding the other.

The way these cables are made is as follows:—Round the copper core a thick layer of jute is laid, which forms a sort of foundation for the insulating material. This material consists

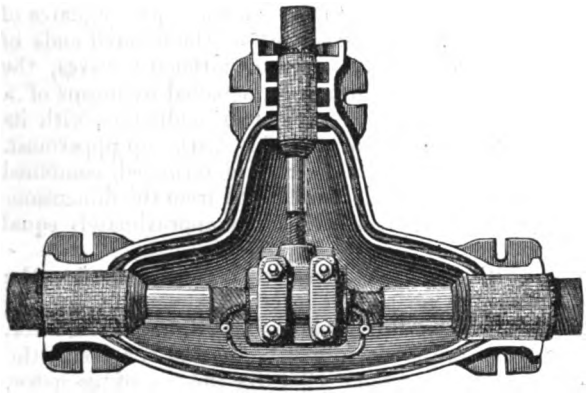


Fig. 4.—Siemens Single Cable Junction Box.

of a special bitumenous compound rendered somewhat flexible by the addition of heavy oils, and with it the jute covering is thoroughly saturated and filled, so that the whole forms a solid mass. As these materials are cheap a very thick insulating covering can be used on a cable without incurring great expense. In the ordinary cables a lead tube is drawn over the insulating material, and this tube is then covered with a strong and well-compounded tape. Next a couple of spiral lappings of iron strip are put on in opposite directions, and finally the whole is covered with layer of heavily-compounded jute yarn.

For the concentric cables for high-tension currents the construction is on very similar lines. Round the centre copper core comes insulation, only thicker than for the low-tension cables. Then we have the outer copper conductors laid evenly round this insulation. Next comes another layer of insulation, followed by the lead tube, the outer coverings of the cable being the same as already described.

Cables constructed in this manner are made not only for feeders and mains, but for branches and connections to customers, so that the system is quite complete. The cables are intended to be laid directly in the ground without further preparation or protection, it being considered that they are strong enough to withstand the effects of any ordinary ill-usage they are likely to be subjected to, and that the protective coverings will be sufficient to preserve the insulation sound and intact.

A special set of junction boxes have been worked out to suit these cables, both ordinary and concentric, as well for joining them end to end as for local connections for customers, and for service mains. The nature and construction of these boxes will best be seen from the figures. Fig. 4 shows a junction box for the single cable, with a third aperture for taking off a connection. The through junction box is exactly similiar, only without this additional aperture, so that it is oval in form, as in Fig. 5. Fig. 5 shows a through junction box for a concentric cable. It will be observed that the outer conductors are spread out in a circle and clamped between two metal surfaces, the bolts which tighten the clamps also serving for the through connection. The box for taking off connections is of the same shape as Fig. 4. It will be seen that these boxes are constructed in halves, the edges being grooved out all round and filled with packing. When applied to a cable, the cable is opened and all the outer coverings taken off except the insulation, which projects some way into the box. All junctions are made by means of clamps, and no solder is used. When a connection is completed the top of the junction box is put in its place, and the two halves are held together by strong clamps. In each junction box there is a hole closed by a screw plug. After a box is clamped together it is filled with a heavy mineral oil through this hole, which improves the insulation and keeps it constant. These junction boxes, as a rule, lie buried in the ground in the lines of the cable, which is usually laid under the footpath.

The Siemens system has been very largely used in Berlin for low-tension currents, and a description of its working will be found in Prof. George Forbes' Paper on "Foreign Central Stations," read before the Institute of Electrical Engineers in February last (*Electrician*, March 8, April 19 and 26, 1889). Both in Rome and Milan the concentric cables have also now for some time been employed successfully for alternating currents of 2,000 volts, but in Rome the cables have been additionally protected by being laid in wooden troughs filled with cement.

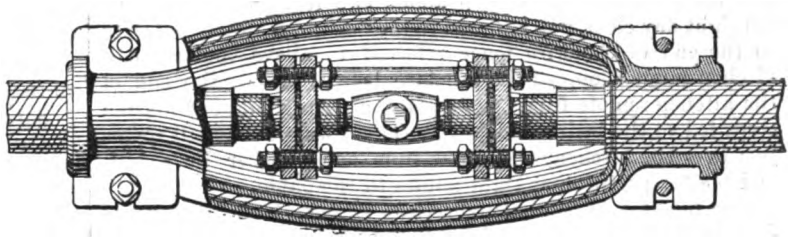


Fig. 5.—Siemens Concentric Cable Junction Box.

Profiting by the experience of their Berlin house, Messrs. Siemens Brothers, of Charlton have lately commenced the manufacture of this class of cables in England, and the concentric pattern is being laid down on an extensive scale by the London Electric Light Corporation (Limited). All their cable is tested for an hour with an alternating current of 5,000 volts before delivery. The cable is about 3in. in diameter over all, and is being laid about 6in. to 10in. deep in the soil under the footpaths. The cables being comparatively cheap in themselves, and easily and cheaply laid, much interest will naturally be felt in the way they work during the next two or three years.

(To be continued.)

Electrical Phenomena at the Santis Observatory.—Remarkable electrical phenomena are witnessed at the new observatory on the steep and isolated Säntis (8,215) in Northern Switzerland. Thunderstorms are extremely frequent; thus, in June and July last year, only three days were without them. As a rule, thunder peals from midday till evening. The noise is short, partly owing to shortness of flashes, and partly to the small amount of echo. The thunderstorms come on quite suddenly in a clear sky. One of the surest indications of their approach is the bristling of the observer's hair. During hail, the iron rods of the house give a hissing sound, asociated with luminous effects.

Digitized by Google

A SEVERE CASE OF DAMAGE BY LIGHTNING.

BY PROF. ANDREW GRAY, M.A.

Early in the morning of January 7th a thunderstorm of some violence broke over Carnarvon and Anglesey, but passed rapidly away with a few vivid lightning flashes, accompanied by loud peals of thunder. A day or two afterwards I heard it reported that a house in Llandegfan, a small village nearly opposite Bangor, on the Anglesey side of the Menai Strait, had been struck by lightning and almost completely wrecked. I lost no time in visiting the place, and carefully inspecting the house and its surroundings. In view of the recent discussion regarding protection from lightning, I have thought that an account of the situation of this house, the probable course of the discharge, and the damage done, may be interesting to the readers of *The Electrician*.

The house is one of two small adjoining houses which stand near the top of the high ground above the Garth Ferry, on the Menai Strait. These houses stand at right angles to a narrow lane, on either side of which is a bank of earth about three feet high, surmounted by a straggling hedge of hawthorn. Behind the house there runs along the bank, beside the hedge, a fence consisting of upright slabs of slate, placed closely together, and held at the top by a double line of ordinary iron fencing wire twisted round the posts. This wire formed, with the exception of a single gap, a continuous conductor from post to post, from a point a few inches from the back wall of the house and about three feet from the gable end next the lane, to a distance of about 38 yards along the lane, where the bank gave place to a stone wall.

The house struck was the one next the road. It is two low stories in height, and contains on the ground floor a kitchen or living room extending from front to back, and a narrow parlour or bedroom. The kitchen is next the lane, and the flue from it runs up the gable, and terminated before the disaster in a brick chimney at the top about two feet in height. An old eight-day clock was fastened to the back wall, nearly opposite to the end of the wire fence referred to above, and a small kitchen range occupied the fireplace below. From the end of the kitchen remote from the fireplace, a narrow flight of wooden steps led to the bedrooms above. There were two small rooms just over the kitchen, separated from one another by a lath and plaster partition at right angles to the gable.

The inmates of the house retired to rest about 10 p.m. on January 6th, leaving a small fire in the kitchen grate, and awoke at about 1 a.m. to find their house nearly in ruins, and their furniture broken to matchwood. The house had been struck by lightning, which had demolished the chimney at the top of the gable, tearing it away from and destroying a portion of the roof near it, and committing great havoc in the interior, especially in the kitchen and small room below.

On examining the house I found that the line of discharge, or at least one part of it, must have been to the chimney top, thence to a point of the flue just under the ceiling of the kitchen, thence across the corner of the room to the clock, and through the wall to the wire fence, along the wire fence to its end, and across the road there from one bank to the other. Just under the ceiling was a hole from the flue to the interior of the house, and where the clock had stood another hole was pierced to the fence. Each of these holes was wide at the wall face, but within the wall was only about wide enough to admit a walking-stick. That the discharge had passed along the wire fence was plain. At a gap about two feet in width in the wire near the further end, the wet earth had been scattered about so as to thoroughly smear all the twigs of the hedge with mud. The stone wall about four yards further on, at the extremity of the fence, was thrown down, and the bank opposite at the other extremity of the road torn up. Within the house there seemed to have been a violent explosion—the clock, dresser, and drawers were smashed to pieces, the door broken to splinters, the glass broken in the windows, and the stairs leading to the rooms above destroyed. Strange to say, none of the inmates were at all injured—except, perhaps, the wife of the tenant of the house, who says she was awakened by a blow from a falling beam. There was no sign of scorching on any of the articles destroyed.

What I imagine took place is this. A discharge occurred between the cloud and the chimney, and thence along the sooty flue to the point below the ceiling, destroying the chimney and the roof. The further course of the discharge was across the corner of the room and through the wall to the wire of the fence outside, and thence along the wire to earth at the further end. There was nothing to show that any discharge took place through the lower part of the flue and the grate, as the latter was uninjured. The people sleeping above, five or six in number, seem to have been protected by the floor and the beds beneath them from what must have been a violent explosion below. It is remarkable that there was a sufficient discharge at the extremity of the wire fence to throw down the wall and tear up the ground. The wire was connected to earth by a close fence of slate slabs, and besides, was at many places completely buried in the thorn-hedge. The fence and hedge must have been wet, as the night was very stormy, and so there must have been great leakage from the wire. There was no effect of the discharge apparent on the wire.

MULTIPLE RESONANCE IN CONNECTION WITH THE EXPERIMENTS OF HERTZ.*

BY MM. E. SARASIN AND L. DE LA RIVE.

One of Hertz's experiments consists in exciting oscillations in two straight parallel conductors of equal length, each isolated at one end, and connected at the other perpendicularly to a plate of brass placed parallel to one of the capacity plates of the primary oscillator. The reflections at the isolated ends of the secondary conductors give rise to stationary waves, the nodes and internodes of which may be detected by means of a circular resonator placed between the two conductors, with its plane normal to their direction, and the spark gap uppermost. Hertz found that the wave length thus determined, combined with the frequency of oscillation calculated from the dimensions of the primary oscillator, yielded a velocity approximately equal to that of light.

Sarasin and Rive find, however, that they can alter the distance between the nodes and internodes, without altering the primary conductor at all, by employing a different resonator. If the waves given out by the primary are all of one period the wave length should be the same whatever the size of resonator, although the spark distance may be lessened if the resonator is not properly timed to the electric vibrations. The authors have made a great number of experiments with three types of resonators. With each resonator used they have altered the dimensions and arrangement of the primary conductor, the distance apart and length of the secondary wires, and the position of the resonator with reference to them; and in all cases have found that the distance between the nodes is the same for the same resonator, although varying with the resonator used. The annexed table gives the results of their final experiments:—

Distance of Nodes from the free ends of the Secondary Conductors.

	Resonator 35cm.		Resonator 50cm.		Resonator 75cm.	
Distance.	Observed.	Calculated.	Observed.	Calculated.	Observed.	Calculated.
Node.	m.	m.	m.	m.	m.	m.
1st ...	0·60	0·60	0·78	0·78	1·24	1·24
2nd ...	2·03	2·07	2·73	2·67	4·19	4·23
3rd ...	3·56	3·54	4·46	4·56	7·23	7·22
4th ...	5·09	5·01	6·52	6·45		
5th ...	6·45	6·48	8·35	8·34		
6th ..	7·90	7·95				
7th ...	9·42	9·42				

The mean half-wave lengths determined with the three resonators will be seen to be 1·47m., 1·89m., and 2·99m. respectively. The table shows that the distance of the first node from the end of the conductor is smaller than a quarter-wave

* Abstracted from the *Comptes Rendus*, January 13, 1890.

Digitized by Google

length, as is the case with reflection at the ends of open pipes. This distance is very nearly equal to the semi-circumference of the resonator, as the following table shows :—

Resonator.	Distance of First Node.	Semi-circumference.
m.		
0·35	0·60	0·55
0·50	0·78	0·78
0·75	1·24	1·17

This seems to indicate that the reflection in the resonator on the two sides of the spark gap takes place in the same manner as at the ends of the conductor, the two poles of the resonator being internodes always in opposite phase. The authors conclude from the experiments that an ordinary Hertz oscillator gives rise to waves not of one period only but of several, and that each resonator chooses from the mixture the wave whose period corresponds with its own. M. Cornu remarks on these experiments that Hertz's theory rests upon two bases—first, on the hypothesis that the discharges of the induction coil give rise to a disturbance of *fixed* period depending on the dimensions of the primary oscillator; and, secondly, on the *observation* of an *apparent periodicity* in the electrical state of the secondary conductor. The calculations by means of which Hertz obtains the period T of the primary oscillation are questionable, and the wave length λ is obtained by means of a resonator, on the assumption of analogy with elastic vibrations. The velocity V of propagation of the induction is then obtained from the equation $\lambda = V T$, and this velocity comes out in certain cases to be the same as that of light. The above experiments, according to M. Cornu, throw grave doubt on Hertz's theory, for they show that the oscillatory state of the secondary conductor, instead of being invariable, as would be an elastic column under the action of a single periodic force, depends essentially on the resonator employed. It is either necessary to conclude that the period T is not fixed and single valued, which is contrary to Hertz's hypothesis, or else V itself must be variable, which is absurd.

THE COAD BATTERY.

We inspected this week the Coad battery and concomitant apparatus at Mr. Coad's show rooms 31, Soho-square. The principal novelties claimed for it are, we understand, the solution, and the method of connecting up the plates. The solution is a secret—one might say that there is no novelty in this, as we have frequently heard of batteries brought out with secret solutions; but since the zincs amalgamate themselves, we may presume it is a solution of some mercury salt. There are two carbons in each cell, which rest against platinum pegs, tapped through the ebonite of the containing box; the zinc also rests against a similar platinum peg, the joining up being done by connections outside the cells, between the various pegs, the connections being afterwards all cemented in. Various forms of battery are on show, chiefly for mining purposes. In these latter the lamp is enclosed in an air-tight chamber under pressure, and arranged so that directly the pressure is relieved, by breakage or tampering, the circuit is broken. We were shown a battery weighing about 7lb., which had been running a (*circa*) one candle-power lamp for 17 hours, and which was still giving a good light. Mr. Coad makes use of a specially cut bull's-eye lens on these batteries, which appears to work well. We do not quite see, however, what advantages this has over an ordinary plain bull's eye, nor do we see why in his list Mr. Coad should speak of a battery with a one candle-power lamp and bull's eye as giving "10 candle-power" for ten hours. Mr. Gordon has given a very favourable report on the battery. As a battery to put in unskilled hands it is certainly a very well-arranged one, and apart from the local action due to the zinc being in contact with the platinum peg, in the liquid, the method of joining up is very convenient, allowing the use of plain carbon and zinc plates without any fixed connection on them.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-night) FRIDAY, January 31st.

INSTITUTION OF MECHANICAL ENGINEERS.

7:30 p.m. Annual General Meeting.

ELECTRO-HARMONIC SOCIETY.

8 p.m. Smoking Concert at the St. James's Hall Restaurant.

ROYAL INSTITUTION.

9 p.m. Lecture: "Smokeless Explosives." By Sir FREDERICK ABEL, F.R.S.

SATURDAY, February 1st.

ROYAL INSTITUTION.

3 p.m. Lecture: "The Natural History of the Horse, and of its Extinct and Existing Allies." By Prof. FLOWER, F.R.S.

MONDAY, February 3rd.

ROYAL INSTITUTION.

5 p.m. General Monthly Meeting.

LONDON INSTITUTION.

5 p.m. Lecture: "A Visit to Mount Athos." By the Rev Prof. J. P. MAHAFFY.

SOCIETY OF ENGINEERS.

7:30 p.m. Ordinary Meeting. Inaugural Address by HENRY ADAMS.

SOCIETY OF ARTS.

8 p.m. CANTOR LECTURE II. 3. "The Electro-Magnet." By Prof. SILVANUS P. THOMPSON, D.Sc.

TUESDAY, February 4th.

ROYAL INSTITUTION.

3 p.m. Lecture, "The Post-Darwinian Period." By Prof. G. J. ROMANES, F.R.S.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be read: "Bars at the Mouths of Tidal Estuaries." By W. H. WHEELER, M.Inst.C.E. Monthly Ballot for Members.

ROYAL VICTORIA HALL.

8:30 p.m. Lecture, "Algeria and Morocco." By HENRY BLACKBURN.

WEDNESDAY, February 5th.

CIVIL AND MECHANICAL ENGINEERS' SOCIETY.

7 p.m. Ordinary Meeting. Paper to be read, "Recent Progress in Sewage Treatment." By C. H. COOPER, A.M.I.C.E.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Paper to be read, "High-Speed Knitting and Weaving without Weft." By ARTHUR PAGET.

THURSDAY, February 6th.

ROYAL INSTITUTION.

3 p.m Lecture, "Sculpture in Relation to the Age." By EDWIN R. MULLINS.

LONDON INSTITUTION.

6 p.m. Travers Lecture, "The Law of Buying and Selling." By AUBREY J. SPENCER, M.A.

CHEMICAL SOCIETY

8 p.m. Ballot for the Election of Fellows. Papers to be read, "The Oxides of Nitrogen." By Prof. RAMSAY, F.R.S. "Studies on the Constitution of Tri-Derivatives of Naphthalene." By Dr. ARMSTRONG and W. P. WYNNE. "On the Action of Chromium Oxychloride on Nitrobenzole." By G. G. HENDERSON, B.Sc., and J. MORROW CAMPBELL, B.Sc.

FRIDAY, February 7th.

PHYSICAL SOCIETY.

5 p.m. Annual General Meeting. Papers to be read, "On Galvanometers." By Prof. W. E. AYRTON, F.R.S.; T. MATHER; and Dr. W. E. SUMPNER. "On a Carbon Deposit in a Blake Telephone Transmitter." By F. B. HAWES.

SOCIETY OF ARTS.

5 p.m. Indian Section. Paper to be read, "The Utility of Forests and the Study of Forestry." By Dr. SCHLICH.

INSTITUTION OF CIVIL ENGINEERS.

7:30 p.m. Students' Meeting. Paper to be read, "Reclamation of Land on the River Tees." By COLIN P. FOWLER, Stud.Inst.C.E.

ROYAL INSTITUTION.

9 p.m. Lecture: "The London Stage in Elizabeth's Reign." By HENRY B. WHEATLEY, F.S.A.

SATURDAY, February 8th.

ROYAL INSTITUTION.

3 p.m. Lecture: "The Natural History of the Horse, and of its Extinct and Existing Allies." By Prof. FLOWER, F.R.S.

Digitized by Google

The Electrician.

Published every Friday. Price Fourpence; Post Free, Fourpence Halfpenny
Editorial, Publishing and Printing Offices:

No. 1, SALISBURY COURT, FLEET STREET, LONDON, E.C.

Telephone No. 2714. *Telegrams:* "ELECTRICIAN NEWSPAPER, LONDON."

All Communications to be addressed to "THE ELECTRICIAN," *1, Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN."

All letters intended for insertion in "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. Subscribers should receive their copies by the first post on Friday morning.*

"THE ELECTRICIAN" *is on sale at the railway bookstalls throughout the United Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices as above.*

SPECIAL NOTICE.

Owing to the increase in the number of pages of "THE ELECTRICIAN," in order to partly cover the increased postage, we have been compelled to revise the rates for Foreign Subscriptions, which are now as follows:—

	3 months.		6 months.		12 months	
For Foreign Parts and Colonies:—	s.	d.	s.	d.	s.	d.
Within Postal Union	6	6	12	6	24	0
Aden, Borneo, Ceylon, China, India, Japan, Java, Labuan, Mozambique, New Caledonia, Persia, Philippine Islands, Siam, Transvaal, and Zanzibar	7	6	14	6	28	0
The rates for the United Kingdom remain as follows:—	5	0	10	0	19	6

TO ADVERTISERS.

"THE ELECTRICIAN" *offers exceptional advantages to Advertisers.* **It has the largest circulation of any English Electrical paper, and circulates all over the World.**

Particulars relating to Advertisements will be promptly forwarded on application to the office.

TRADE ADVERTISEMENTS *intended for the current issue must be handed in not later than First Post on Thursday morning.*

SMALL PREPAID ADVERTISEMENTS *(for Rates see page xv.) are accepted up to 4:30 p.m. on Thursday.*

TECHNICAL PRINTING.

"THE ELECTRICIAN" PRINTING AND PUBLISHING COMPANY (LIMITED) *beg to inform Electricians, Electric Light Engineers, &c., that they make a specialty of Technical Printing, and have a Staff thoroughly acquainted with Electro-Technology. They can, therefore, promise Accuracy and Despatch in the Printing of Electrical Catalogues and Electro-Technical Literature generally.*

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.

Royal 8vo.

Early in each year is issued "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK. *The* DIRECTORY *was established in 1883, and the 1889 Edition consisted of more than 600 pages of printed matter. The names and addresses of all persons engaged in the Electrical Industries may be relied upon as accurate. Useful Tables and Electrical Formulæ, and information specially compiled for this work are given, together with popularly-written Biographical Notices of the leading Electricians, Electrical Engineers, &c., accompanied in many cases by Portraits.*

The issue for 1890, which will be still further enlarged and improved, is in active preparation, and will be ready next week. Orders should be forwarded at once to the Publishing Office, **1,** *Salisbury-court, Fleet-street, London, E.C.*

CONTENTS OF THE CURRENT NUMBER.

NOTES 307
Magnetism in Iron and other Metals.—IV. By Prof. J. A. Ewing, F.R.S. Illustrated. Continued 312
Underground Mains.—III. By G. L. Addenbrooke. Illustrated. Continued 313
A Severe Case of Damage by Lightning. By Prof. Andrew Gray, M.A. 316
Multiple Resonance in connection with the Experiments of Hertz. By MM. E. Sarasin and L. de la Rive 316
The Coad Battery 317
Meetings of Scientific Societies. 317
TRAINING FOR THE ELECTRICAL INDUSTRY 318
OBITUARY—
Edward Orange Wildman Whitehouse 319
The Institution of Electrical Engineers—
Discussion on the President's Address on "Magnetism." Illustrated. Continued ... 320
The Electrical Trades Committee of the London Chamber of Commerce 321
Physical Society—
"Electric Splashes" 323
Insulation in Marine Work 323
American Notes 325
Paris Notes 326
CORRESPONDENCE—
The "Counter Electromotive Force" of the Voltaic Arc.—Arthur Schuster 326
The Clark Standard Cell.—H. H. Hoffert 327
"Advances in Magnetism."—H. W. Ravenshaw and E. T. Carter 327
The Use of the Term "Electric Splashes."—"A Correspondent 328
Underground Mains.—Gerald St. John Day 328
Electro-Magnetic Appliance for Turning on Gaslight.—John F. Neave 328
Simple Wiring Equations 328
Charlesworth, Hall, and Co.'s Electric Light Engines. Ill. 329
The Woodhouse and Rawson Double-Pole Two-Way Switch. Illustrated 329
The Solignac Arc Lamp. Illus. 330
Trade Notes and Notices 330
PATENT RECORD 330
COMPANIES' MEETINGS, &c.—
The Australasian Electric Light, Power, and Storage Company (Limited) 331
Anglo-American Telegraph Company (Limited) 332
New Companies Registered ... 333
City Notes, &c. 333
Companies' Share List 334

"THE ELECTROTECHNISCHE-ZEITSCHRIFT" OF BERLIN.

In future the above journal (with which has been incorporated "The Centralblatt für Electrotechnik") will be issued weekly instead of fortnightly, the subscription being **£1. 4s. 6d.** *per annum. Single Copies* **6d.; post free, 7½d.**

"THE ELECTRICAL WORLD" OF NEW YORK.

"THE ELECTRICAL WORLD" OF NEW YORK *can be obtained from* "THE ELECTRICIAN" *Office, Salisbury-court, Fleet-street, London, E.C. The Rate of Subscription (payable in advance), is* **£1 1s.** *per annum. Single Copies* **price 6d. each; post free, 8d.**

TRAINING FOR THE ELECTRICAL INDUSTRY.

What shall we make of our boys? Some thousands of anxious parents who have pondered this problem during recent years have fondly imagined that they saw a brilliant solution of their difficulty in the new industry now growing up around the applications of electrical science. They had been assured by all their friends, legal, medical, clerical, mechanical and chemical, that all these professions were overstocked; whilst the manufacturers unanimously complained of the badness of the times. The anxious parent welcomed the suggestion of an electrical career, and his boy was forthwith set loose on the very first track which seemed to lead into the electrical industry. Three months in the laboratory and a month in charge of an electric light machine, and then forth stepped the full-blown electrical engineer blushing with consciousness of his novel dignity.

Such a rush to enter the new profession could not but bring about a serious reaction. Into no profession or industry is there a royal road that will summarily convert the inexperienced youth into an experienced adept. The training for the electrical industry, whether in its mer-

Digitized by Google

cantile or its professional aspect, needs to be just as strict, just as thorough, just as practical, as the training for any other industrial career. Let us consider what is wanted to make up the whole equipment of the electrical engineer. He must be, in the first place, an *engineer*, competent to deal with running machinery, with steam engines, boilers, shafting, capable of estimating for, and, if need be, of designing the same, and of undertaking their erection and management. He must be a mechanician, capable of devising and of constructing with his own hands the machine, or instrument, or tool that he requires. He must be a bit of a civil engineer, too, knowing something in a practical way about foundations and building construction. He must be thoroughly familiar with drawing-office work, including estimating from working drawings. He must, in the second place, be a thorough *electrician*, not merely an engineer with a skin-deep varnish of electrical knowledge. He must have acquired his knowledge of electricity not from books nor from men, but at first hand by having himself worked in the laboratory, in the testing-room, and in the dynamo-room, acquainting himself thoroughly with the thermal, mechanical, chemical, and magnetic properties of electric currents. As every engineer must be also to a fair degree a draughtsman, so must every electrician be also to some degree a chemist: he must have a working knowledge of the chemical properties of the materials with which he will have to deal. If, further, he proposes to fit himself for the manufacturing branch of the industry he must spare no pains to make his training as a mechanical engineer as perfect as possible, and must have as practical an acquaintance with the work of the pattern-shop, the foundry, the forge, and the fitting-shop, as though engines and pumps, instead of dynamos and electric motors, were going to be the products of his future factory. Lastly, for whatever branch of the industry he proposes to prepare himself, he will find that he will never have had time enough to acquire all the mathematics that he would have found useful in his work.

A formidable programme this for the furnishing forth of the budding electrical engineer; yet short of this none need expect to find himself rising to the top of his profession. He who is merely electrician without being trained engineer may indeed find a humble place in the testing-room of the factory; but a front rank in the industry is impossible for him. He who is merely engineer without being a trained electrician can never feel full confidence in or familiarity with his work, and will always be behindhand in the race for progress. The double training is essentially necessary: how to gain it is the real problem. No apprenticeship to a firm of engineers can give it; no college course, however complete or costly, can pretend to turn out the finished product. College training, if conducted not under schoolmasters, but under men who have themselves worked in their respective departments, may do much. It can train young men for the drawing-office, or for the testing-room; it may teach them the use of tools—even of machine tools to some extent; but college instruction is essentially imperfect in this respect: that however complete its equipment of laboratories and workshops may be (to say nothing of its lecture-rooms), however experienced the instructors who manage them, the work that is done in them is not being done under commercial conditions, nor under an organisation like that of a factory: it lacks, and must always lack, the stimulus of commercial enterprise. But if the college training is defective, so also is the system of apprenticeship in the shops. Nearly all large engineering firms derive a considerable income from premiums paid by the sons of wealthy parents, who are permitted, for a sufficiently large consideration, to enter the works and spend a few hours every day in company with the real workers. How many premium pupils eventually become competent engineers it is very difficult to ascertain: the percentage cannot be very high. Those boys who enter without premiums as bound apprentices have such long hours of labour, and so few chances of acquiring an all-round knowledge, that few of them can hope to become fully trained, unless by some unusual favouring circumstance they can add to their shop work a training in electrical laboratory work, in mathematics, chemistry, theoretical mechanics, and draughtsmanship.

The most desirable training is that which combines the respective advantages of both methods, which shortens the apprenticeship of the shops to two or three years, and adds two years of special training in the electrical laboratories of some one of those colleges which possess specially organised departments. It depends greatly upon the temperament of the young aspirant whether he should serve his apprenticeship in the shops immediately on leaving school, or whether he should take two years of laboratory training before he enters on his factory apprenticeship. For youths under 16 years of age probably the latter is preferable; whilst the former course is undoubtedly to be preferred for those who are older. For them apprenticeship in the shops must be now or never. If they wait till they are older they will never become good mechanics. We know that these views are shared not only by leading men in the profession, but by those who manage the electrical training establishments. Our best pupils, says one of the latter, are those who have knocked about, if even only for a year, in the shops; our worst are the fine gentlemen who come from the fifth or sixth form, and are afraid to dirty their hands.

Much as the various electrical schools and technical colleges have done for the progress of the electrical industries, they would do still more if they could make every one of their pupils realise that a college course can never supplant the apprenticeship of the shops, and can give but half a training—namely, that half which in turn the apprenticeship of shops will not and cannot afford.

OBITUARY NOTICE.

EDWARD ORANGE WILDMAN WHITEHOUSE.

We regret to announce the decease of Edward Orange Wildman Whitehouse, F.R.C.S., F.R.A.S., aged 73, which occurred at 19, Salisbury-road, Brighton, on Sunday last, the 26th January.

For many years Mr. Whitehouse took a great interest in all electrical matters. In conjunction with Mr. John Brett, who was the first concessionaire of the submarine cable between England and France, he was engaged in bringing out a telegraph instrument for printing in Roman characters. From early in 1854 he was almost exclusively occupied in experimenting, with a view to devising apparatus for working the Atlantic cable; and in 1856 he gave up a very large surgical practice at Brighton to devote the whole of his time to this object, being appointed electrician to the Atlantic Telegraph Company, his connection with which ceased on the failure of that company, and he again devoted considerable attention to many electrical devices, amongst others to electrical checks in connection with passenger fares in tramways and omnibuses. The last time he was professionally engaged in telegraphy was in 1861, when he was consulting electrician for Messrs. Glass, Elliott, and Co. during the laying of the Malta-Alexandria cable.

Mr. J. C. Laws, Mr. Frank Lambert, Mr. Joseph May, and Mr. H. A. C. Saunders, of whom only the latter survives assisted him in his electrical work from early in 1854 until his connection with telegraphy ceased, and he was also the cause of many others now well known in submarine telegraphy adopting that profession.

Digitized by Google

THE INSTITUTION OF ELECTRICAL ENGINEERS.

DISCUSSION ON THE PRESIDENT'S ADDRESS ON "MAGNETISM."

(Continued from page 291.)

The following is the authorised abstract of the adjourned discussion on Dr. Hopkinson's Presidential Address, which took place on Thursday, the 23rd inst.:—

Mr. SHELFORD BIDWELL, in re-opening the discussion, said the address was above criticism and required no comment, but as he was greatly interested in the subject himself, he wished to refer to the portion of the paper relating to the influence of stress on magnetisation. If a long thin iron wire be suspended vertically and subjected to longitudinal magnetising forces, its curve of magnetisation resembling Fig. 1 (*The Electrician*, January 10th, p. 246) is easily obtained. If now the wire be stretched by a weight, the curve of magnetisation rises more rapidly at first, but subsequently bends over and cuts the ordinary curve and remains below it as the magneting force increases. The point of intersection is known as the *Villari critical point*, and the change in the relative permeability is called the *Villari reversal*. Converse effects were obtained by Joule in 1840, who showed that a bar is lengthened by magnetisation until the magnetising force reaches about 120 C.-G.-S. units, when no further elongation was observed. Joule's experiment has often been repeated, but until comparatively recently no one seems to have used much greater magnetising forces than those originally employed. The speaker, however, has subjected wires to forces of 800 or 1,000 C.-G.-S. units, the results of which are shown in the diagram Fig. A. From this it will be seen that for forces above 100 the elongation diminishes as H increases, and eventually magnetisation shortens the bar. Similar curves for nickel

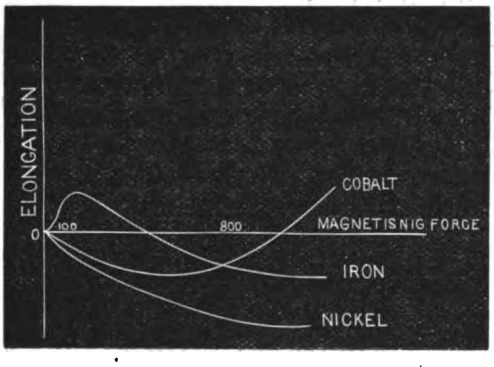


FIG. A.

and cobalt are given in the same diagram. In his "Applications of Dynamics to Physics and Chemistry" Prof. J. J. Thomson has shown the elongation and retraction of iron to be closely connected with the Villari reversal, and applying a similar argument to the properties of cobalt, Mr. Bidwell predicted that this metal would present a Villari reversal of an opposite character to that observed in iron; but on trying the experiment the reversal was not found. Probably, however, he had misunderstood Prof. Thomson's argument, for quite recently the latter had predicted a Villari reversal when cobalt was compressed, and this was verified by experiment.

Prof. ROBERTS-AUSTEN stated that there were, from the point of view of a metallurgist, several points in the admirable address to which he wished to direct attention. The President has said that wrought iron on cooling does not evolve heat as carbonised irons do. Prof. Austen, however, reminded the Society that electro-deposited iron (which is pure iron) does on cooling down from 1200°C. evolve heat suddenly when the temperature falls to 858°C. This points to a distinct molecular change in the iron itself wholly unconnected with the presence of carbon. The President, he said, only appeared to recognise a single critical point at which heat is evolved, and to that he always applied the name of "recalescence." Osmond has, however, shown that there are at least two perfectly distinct phenomena which may be observed in cooling masses of iron. First, there was the transformation of hard β iron into soft, or α iron; and, secondly, the "recalescence" of Barrett. Referring to Dr. Hopkinson's remarks on the "double recalescence of soft steel," he said that the two distinct evolutions of heat were due to totally different causes, and not to any want of uniformity in the mass. As regards the President's statement that the magnetic properties of iron "appertain to the *molecule* and not to the *atoms* of the mass," Prof. Austen asked, Is it a great step from this to admit that more than one kind of iron can exist? Normal iron may, he urged, under certain conditions, pass into an allotropic form, in which the arrangement of the atoms in the molecule is different from that of ordinary iron; and the physical properties of these two kinds of iron are as totally distinct as those of the allotropic modifications of sulphur and phosphorus are from those of the elements in their normal forms.

Prof. S. P. THOMPSON said the behaviour of the nickel-iron alloy reminded him of a specimen of natural alloy of the same two metals shown to him some years ago by M. Becquerel. This differed in its magnetic properties from Dr. Hopkinson's samples, for although it was non-magnetic when first obtained, it became magnetic on being heated and allowed to cool. Alluding to the supposed instability of iron, as mentioned by Prof. Ewing, Dr. Thompson said that in a Paper on the Mechanism of Magnetisation, Chwolson* had arrived at some very interesting results. The experimenter endeavoured to distinguish between temporary and subpermanent magnetism, and his curves show that the former increases regularly at first and afterwards more slowly, whilst the latter makes a sudden rise when the magnetising force reaches a certain value, and afterwards remains nearly constant as the force increases. The sum of the two effects gives the usual magnetisation curve (*see* Fig. B). Referring to the question of "permeability," Dr. Thompson described a simple apparatus for measuring that quantity which he had recently devised for workshop purposes. This consists of a slab of good iron having a rectangular hole through it. One end of the hole is truly surfaced, and at the other end a hole is drilled in the plate parallel to the length of the rectangle. Through this hole the rod to be tested is inserted, and its faced end rests on the plane surface at the bottom of the rectangular hole. A current is then sent through a solenoid surrounding the test rod, and the force required to detach the rod from the surfaced end is measured by a spring balance. The permeability is then calculated from the formula

$$\mu = \frac{1317}{H}\sqrt{\frac{P}{A}},$$

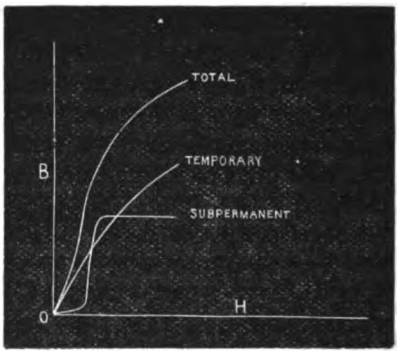


FIG. B.

where H is the magnetising force used, P the force of detachment in lbs., and A the area of the rod end in square inches.

Prof. AYRTON asked Dr. Thompson whether the character of the surfaces in his contact affected the results obtained by his new apparatus. He also said the curves for temporary and subpermanent magnetism referred to by the same speaker were very interesting, and had a practical significance in the construction of electrical measuring instruments in which soft iron is used. Speaking of the magnetic properties of iron at high temperatures, he inquired whether the President had tried if these properties were regained at a white heat, for he remembered reading a pamphlet by Dr. Wormwell that such was the case. On roughly trying the experiment, by heating a piece of iron in a blow-pipe flame, and bringing a magnet near it, he had only found one out of three pieces to give any signs of magnetisation, and of this he was not quite certain. Another question on which he desired information was an apparent anomaly in the magnetisation of two iron rings, which he had constructed some years ago from the same bar, and annealed together. One ring is continuous, whilst the other is divided at one point by a narrow slit. On determining their magnetisation curves, the induction in the divided ring is found to be considerably below that in the whole one for low values of the magnetising force, but for large forces the induction in the cut ring is decidedly greater than in the uncut one. Another curious effect with the same rings and which has hitherto remained unexplained, is that the deflection of the ballistic galvanometer caused by changing the magnetising current from +A (amperes) to −A is different from that produced by changing it from −A to +A, and this difference remains however many times the reversals are made.

Mr. SWINBURNE, alluding to Weber's theory of magnetisation, inquired if any experiments had been made with the object of

Pogg. Ann. (Ergänyunland), VII., p. 535.

Digitized by Google

setting the axes of all the magnetic molecules parallel, and thus reducing the angle of the cone within which, for a given magnetising force, they must all be. As a method of doing this he suggested that a wire be subjected to longitudinal and circular magnetisation simultaneously. Referring to the terminology of the subject he said the word "magnetisation" generally conveyed very vague ideas to the average mind, and thought its use should be avoided.

Mr. PREECE described the methods of testing magnet steel used by the Post Office authorities, and promised to add a table of tests to his remarks as printed in the *Journal*. The tests are made by two methods: first, by determining the force required to detach an armature; and second, by the magnetometer method. A great improvement, he said, was made in the magnetic quality of steel by the addition of about 3 per cent. of tungsten, the influence of which was brought into prominent notice by the Alvane steel exhibited at the Paris Exhibition in 1881. Speaking from the records of the Post Office tests, he was sorry to say that the quantity of magnet steel is seriously deteriorating, for in 1883 steel giving a permanent induction of over 5,000 C.-G.-S. units was obtainable, whereas in 1886 this had fallen to 3,700. Recent tests show a still further deterioration, for one specimen gave 2,320, another 1,948, and a third 1,411. The subject, he thought, required the careful attention of manufacturers, and he hoped that immediate steps would be taken to improve the quality of magnet steel. On examining the numbers obtained by Continental observers, he found that the maximum value had been obtained by Kohlraush, and was 3,900. Mr. Preece also directed attention to an article by Prof. Trowbridge in the current number of the *Phil. Mag.*, which gives particulars of an alloy of nickel and tungsten.

Mr. EVERSHED confirmed Mr. Preece's remarks on the deteriorating quality of magnet steel, and said that in testing magnets he found it very convenient to use a test coil and galvanometer. Referring to nomenclature, Mr. Evershed said he was one of those who thought there was no need to use the word magnetisation in its present ambiguous sense, and that the ideas of polarity, magnetic moment, free magnetism, &c., were not required, except (perhaps) for permanent magnets. Even with these, m, now that the President has given a definite meaning to "coercive force," the value of H, together with the permeability, seemed to him to give all the necessary information. He also thought the word "induction" should be defined to mean what is generally called "total induction," and a new name should be given to density of induction, or induction per unit area. For some time past he and his colleague, Mr. Vignoles, have been in the habit of using the word "Thomson" to denote a line of force, but they would be quite willing to adopt any other name which would meet with general approval. Quite recently he had been engaged with Mr. Vignoles in investigating the properties of iron when subjected to magnetic cycles, such as occur in transformers, and had found it a great convenience to wind the transformer with two primaries. In one of these a constant current is maintained, and the whole cycle is obtained without reversing the testing current in the other coil. Speaking of the instability referred to by Prof. Ewing, Mr. Evershed said their results gave no indication whatever of such a phenomenon, and as to the effect of vibration, they found that a good blow with a hammer only produced a change of about 2 per cent. at the most sensitive part of the curve. Prof. Ewing's results, he ventured to think, might be due to want of endlessness in the specimens tested.

Some discussion took place between Profs. AYRTON, THOMPSON, and PERRY, and Messrs. EVERSHED and VIGNOLES as to whether there was any advantage in having two primaries on the transformer used in the experiments on magnetic cycles, but no very clear understanding was arrived at, excepting that the latter gentlemen considered it much more convenient to change the magnitude of a current than to reverse it.

Mr. A. P. TROTTER asked the President whether the sample of nickel iron alloy whose properties were represented in Fig. 9 (*The Electrician*, January 17, p. 271) was unique, or whether other alloys have been found to give similar results. The remarkable peculiarities of this specimen suggest the possibility of copper, lead, &c., being cooled low enough to become more magnetic than Mr. Preece's magnet steel.

The PRESIDENT, in replying to Sir W. THOMSON'S remarks on recalescence, said that in heating the metal a considerable absorption of heat occurs at about 30°C. above the temperature at which recalescence takes places on cooling, but his experiments proved that the changes in the magnetic properties follow precisely the absorption and liberation of heat both in ascending and descending. Referring to Prof. Ewing's remarks on what he called "hysteresis of nickel steel," shown in Fig. 9, Dr. Hopkinson said he thought the word hysteresis not very appropriate when applied to this phenomenon, for he considered the peculiarity more analogous to change of state from liquid to gas or *vice versâ*—as in the case of water, for example, these changes can be considerably retarded by adopting suitable precautions. Prof. Roberts-Austen had, he said, alluded to the liberation of heat when iron changed from the non-magnetic to the magnetic state. The phenomena accompanying this change seemed to him (the President) to be analogous to "boiling with bubbling," where the temperature of the liquid is first raised considerably above the boiling point, and a sudden liberation of vapour brings down the temperature. As regards Prof. Ayrton's question relating to the return of the magnetic property at high temperatures, he could only say that he had not observed it, but the greatest temperature attained in his experiments was about 950°C. To experiment at higher temperatures was a very difficult matter, for copper is then near its fusing point, and platinum cannot be used, because at this temperature it decomposes the silica of the asbestos used to insulate the magnetising and test coils. He could not offer any explanation of the observations on the iron rings described by Prof. Ayrton, and for the present must regard them as anomalous. Referring to the revision of terminology suggested by several speakers, Dr. Hopkinson thought there was no necessity for this, for the terms "pole," "magnetic moment," &c., were most convenient when talking of permanent magnets, whilst "induction" and "permeability" were preferable when the magnetisation of iron was under discussion. In reply to Mr. Trotter, he said that many other alloys had been tried, and one specimen of mixed steel containing five per cent. of nickel gave very similar results to that shown in Fig. 9, but the range between the critical temperatures was considerably shorter, these temperatures being 650°C. and 800°C. respectively. The same sample tested for recalescence was found to absorb heat at about 800°C., and on cooling heat was liberated about 650°, thus showing the close connection between these phenomena and magnetisability. Since last meeting he had tested the variation of specific resistance of nickel steel with temperature, and found that a considerable reduction was produced by cooling it in solid carbonic acid. On heating, its resistance increased slowly and uniformly at first, and afterwards with increasing velocity, until

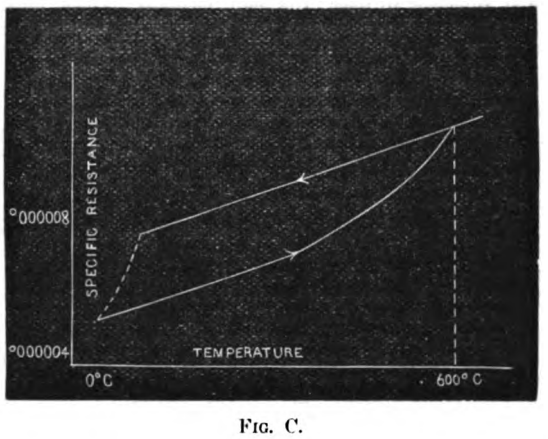


FIG. C.

a temperature of 600°C. was reached. At this temperature a sudden change occurred, and the resistance increased more slowly and uniformly as the temperature rose. On cooling the specimen its resistance fell uniformly, until at the ordinary temperature it returned to its initial value. The whole cycle could be repeated by again cooling in carbonic acid and proceeding as before. Fig. C shows diagrammatically the character of the change. Other samples were tested for tensile strength, and when in the ordinary state gave an average breaking stress of 50 tons per square inch, with an extension of 30 per cent.; specimens which had been chilled broke at 85 tons, with an extension of only 8 per cent. This fact, he said, was of vast importance from an engineering point of view, for if such changes in the nature of a mild steel were brought about by its being subjected to a hard frost the consequences would be very serious if such a metal were used in structures.

THE ELECTRICAL TRADES COMMITTEE OF THE LONDON CHAMBER OF COMMERCE.

A meeting of the members of this body was held at Botolph House, Eastcheap, on Monday, Mr. R. E. Crompton presiding.

The SECRETARY (Mr. Kenric B. Murray) having read the minutes of the previous meeting, and the report of the correspondent for the intervening period,

The CHAIRMAN said that, as all the members knew, the Chamber had been taking considerable pains to make the forthcoming Electrical Exhibition at Edinburgh as popular as possible, but in spite of all their efforts they had not succeeded in doing so. If any gentleman had anything further

Digitized by Google

to say as to what he thought should be the duty of the Committee under the circumstances, the members would be glad to hear him. He (the speaker) thought it was a very good proof of the surfeit that they had recently had of exhibitions, that nobody seemed to be in the least interested in the one to be held at Edinburgh.

Mr. PRICE said that reports were being very diligently circulated in every paper that the whole of the space at the Exhibition had been applied for three times over.

Major FLOOD-PAGE remarked that he had been abroad for some weeks, and he had not had any communication from Edinburgh, but he had heard that the French Government had recognised the Exhibition, and that the Exhibition authorities were going to accept the French Government's electrical exhibits, paying all the expenses of bringing them over; and he also heard, what Mr. Price had just said, that there was to be a very large number of exhibits at the Exhibition, and that it was going to be a great success.

The CHAIRMAN asked whether, under the circumstances, it was the pleasure of the members to do anything further in the matter.

Major FLOOD-PAGE suggested that they might ask the Exhibition authorities for a list of the promised exhibits. When he was in Berlin the other day he heard that a very large German organisation was going to exhibit in Edinburgh.

Major Flood-Page's suggestion was then agreed to.

The CHAIRMAN said that the next subject on the agenda paper was with regard to the British Association screws. Mr. Trotter and himself had taken some trouble in the matter, because they thought it was a very useful thing for the Section to take up. Their great wish was to have a universal screw adopted by the electrical trade, and he thought they could get the trade to accede to their wishes. The way they proposed to set about the work was this: Mr. Trotter would find out by means of a circular letter the size of the screws the trade were mostly using. They then proposed to obtain alternative estimates for 25 or 100 complete sets, not only of the standard screwing tackle, but to send out a few dozen of each kind of screws in use, so as to let people test their comparative merits. When they found out what the cost of that would be, they would send round the hat for subscriptions in order to get a guarantee fund sufficient to meet the cost incurred. Their object was to distribute and make thoroughly known the standard screwing tackle and the sets of screws. What he was anxious to know was whether the game was worth the candle to make it their object to get a standard screw. What he was going on to suggest, if it pleased the Committee to proceed with the matter, was, that a small committee, consisting of one or two members besides Mr. Trotter and himself, should be appointed to try and find out the wishes of the trade in general on the subject.

Mr. J. SWINBURNE proposed and Major FLOOD-PAGE seconded a resolution giving effect to the recommendation.

The CHAIRMAN then went on to say that the question of the County Council surveyors and their dispensing powers had been brought before him some time ago. It affected the whole of the electrical trade which had anything to do with the construction of buildings for electrical stations in London. Every building in London had to be put up under the Metropolitan Building Act, which had been always unworkable for honest people, but had been a very good means of sheltering the "jerry" builder, and of putting difficulties in the way of those who wished to make changes and improvements in their property. The complaints from architects on the subject were very wide and deep indeed. In the days of the Metropolitan Board of Works the grievance did not press very hard, because in those days they looked to their district surveyor, who was entrusted with certain dispensing powers, and who made it his business to see that he had to deal with a good architect and an honest contractor, so that very little harm resulted from that practice. But the new County Council had determined to take away all such dispensing powers, and the result had been a dead-lock. He was not very conversant with the Act himself, and so he had got Mr. Slater, an architect who had done a great deal of work on central stations, to give his help in the matter. The object of the architects in appealing to the Chamber on the subject was that, as they themselves as a body were about to petition the County Council to bring in a Bill for the amendment of the Act, they thought if other trades would petition the County Council as well, the purpose which they were aiming at would be accomplished. He then read a letter from Mr. Slater fully setting forth in detail the grievances which owners of house property now suffer under the Metropolitan Building Act.

Major FLOOD-PAGE said that there could be no doubt that the subject was one of very great importance, but it seemed to him that they were hardly the Section to take up the reform of the Metropolitan Building Act. It was a very big question, involving the complete recasting of that Act, and it was one which the Section could not by itself possibly deal with. They had the very great advantage that the Chairman of the Chamber was also deputy-chairman of the London County Council, and they would therefore have a very good chance of getting what they wanted carried out. He would therefore move—

"That the Chairman of this Section be requested to draw the attention of the Council of the Chamber to the inconvenience to this Section of the Metropolitan Building Act, with a view to their consulting all the Trade Sections interested in the matter, with the ultimate intention, if the Council approve, of bringing the subject before the London County Council."

Mr. WHARTON seconded the resolution, which the Chairman put to the meeting, and declared carried.

The CHAIRMAN said that now that the Chamber had been the means of bringing them a great deal together his object was to try and see if they could get as much mutual benefit out of it as possible, and he wanted to propose, in the most timid way to commence with, that they should try and see how far they could benefit one another by contributing useful information on the subject of producing electricity. There was no doubt that in certain trades this interchange of information had been extremely useful. As an example, he instanced the iron and steel trade. The great developments of the steel trade arose from the early meetings of the Iron and Steel Institute. He thought it would be too much to hope for similar results in the electrical industry, but he was of opinion that there was a great deal of information that they could safely communicate to the Section, and that others would be willing to contribute, out of which common fount of knowledge they might all learn something useful to them in their profession. They could, for instance, easily commence in the case of the central supply companies by asking them to furnish the Chamber with something more than the Board of Trade demanded in the shape of annual accounts and certain analyses of those accounts. He had no doubt some companies would refuse to comply with the request, but he could hardly think that those companies would gain by so doing. If they could not only obtain the accounts of all the supply companies at the present time in this country, on the Continent, and in America, but form themselves into an association for distributing the information so obtained, he believed every one in the profession would be willing to join the association, and would unanimously benefit thereby. He was sure that from the statistics they would thus obtain, one man would be able to find out if he were using too much coal, another would discover if he were paying too much in wages, a third would be able to see if his system of distribution were equal by comparison to that of other people, and so on. He could see great difficulties in the way of persuading some people, but he knew that many others would join, because several gentlemen had offered to submit the figures of their companies to himself. He now wished to sound the Section if they thought it would be possible to start such an association. His idea of starting it would be to write not only to the companies in England, asking them to fill up, as far as they pleased, a certain standard form of analysis of accounts, but to the principal companies in America, desiring them to do the same thing. He believed that they would gradually attract more and more to them all those who were really desirous of effecting improvements in the way of producing electricity cheaply.

Mr. SWINBURNE asked what would be the conditions of membership.

The CHAIRMAN thought that there might be a certain defined number of subscribers, from whom it might be necessary to take a small money subscription, which would entitle them to a copy of the *data* furnished. The figures might be compiled in America, England, and Germany by sub-sections.

Mr. SWINBURNE asked whether they would extend their inquiries beyond central stations.

The CHAIRMAN said it should be the wish of all to cheapen the manufacture and distribution of electricity, and everybody he thought should do his best to that end.

Major FLOOD-PAGE thought they would all sympathise with the motion underlying the remarks of the Chairman, but he believed it was hardly possible to exaggerate the difficulty—he was going to say almost the impossibility—for some time to come at any rate—of arriving at what the Chairman was aiming. For example, he had no doubt whatever that many companies would say that it was absolutely impossible for them to give more information to any public body than they could to their own shareholders. That would be an initial difficulty not lightly overcome. Then, again, he had been over some works in Germany within the last few weeks, and he was perfectly certain that the information the Chairman was seeking would not be supplied. If ever they arrived at practically only one system of working electrical companies, as in the case of gas companies, there would be perhaps no difficulty in the way. But he would suggest whether one preliminary step would not help them forward in the proposed direction, namely, to write to all existing companies asking them to send to the Chamber a copy of their reports with their accounts. That would in itself be a practical step, inasmuch as the published accounts were, to a certain extent, public property. There would be no objection on the part of managers or directors to supply the published accounts. Having got all the information together, they would be able to analyse it, and get one step at least in the direction suggested by the Chairman.

The CHAIRMAN said he would like to set their minds at rest on one particular. The point most interesting to them—the cost of producing electricity—was not the whole of the cost. It was a very small portion of it. The other things that made up such a large item of the expenditure were chiefly connected with the working of the companies, and so forth. The cost of producing electricity in a station itself and distributing it did not form a very large part of the whole, and did not let out the secret of the dividend that was going to be paid. That was the reason why the iron and steel people had been able to send out the returns of their blast furnaces, showing how much coke they used, and so on. The ordinary shareholder could not know how many tons of coal or coke were required for making a ton of iron, but if he were a member of the Iron and Steel Institute he could know. Shareholders as a body were not interested in the kind of knowledge he sought to obtain. He was perfectly satisfied that the United States would exchange information with them at once.

Some further conversation took place on the subject, and in the end it was agreed that the Chairman should draw up the draft of a circular letter to be sent to the various companies, asking for the desired data, and submit it to the next meeting of the Section for discussion.

The proceedings then terminated with the usual vote of thanks to the Chairman.

Digitized by Google

THE PHYSICAL SOCIETY.

At the meeting of this Society, held on the 17th inst., Prof. S. P. THOMPSON read a Paper on

"Electric Splashes."

The author stated that he had been engaged for a considerable time in experimenting on the curved figures, generally known as Lichtenberg figures, which are produced by means of electrical discharges on the surface of a non-conductor dusted over with a mixed powder, electrified by shaking. He was anxious to find the cause of the difference of form of the figures formed by the positive and negative discharges respectively. The first questions which presented themselves for solution were whether the character of the figures was dependent on the nature of the non-conducting surface, of the powder, or of the surface from which the discharge was taken.

The results of the experiments showed that neither the nature of the powder nor that of the non-conducting surface had any perceptible effect on the character of the figures produced; but the character of the figures obtained did partly depend on the size, shape, and amount of polish of the conductor from which the discharge was taken. He had discarded the usual mixture of red lead and sulphur, because the red lead was so heavy that the motions of the particles under the action of the electrical forces were very considerably disturbed by the action of gravity; and he had replaced it by a mixture of sublimed sulphur and powdered lycopodium, which he found to answer exceedingly well. The figures were found under some circumstances to have outlying portions which looked so much like splashes that he had called them "electric splashes." The best non-conducting surface he found to be a cake of pitch or resin, which had been completely discharged by passing a flame over its surface immediately before making the experiments.

The author then proceeded to discharge a large cake of pitch in the manner described, after which the knob of a large Leyden jar, first charged positively to a high degree, and then to a high degree negatively, was drawn over the surface, which was then dusted with the mixture of sulphur and lycopodium, giving the well-known Lichtenberg figures with remarkable distinctness. The experiment was then repeated with the alteration of not allowing the knob to touch the surface, when some well-marked splashes were obtained; but many of them were of imperfect shape, owing, as the author explained, to the wind from the points of roughness of the knob, which was not sufficiently well polished.

The author found that the negative figures were more readily spoiled in shape than the positive ones, which was in accordance with the generally admitted fact that a negative charge is more easily dissipated than a positive one.

DISCUSSION.

In the discussion which followed the reading of the Paper,

Prof. RÜCKER stated that he had recently been engaged upon experiments of a somewhat similar character. He had repeated the ordinary experiment of sending a discharge just over a sensitised photographic plate, and had also drawn the knob of a jar over it, and in both cases the marks obtained were of the character expected, viz., the negative ones were rounded while the positive ones were branched. The whole question was one of the greatest importance. In sending a discharge across a lampblack plate he had obtained sparks with black and white cores respectively, according to whether the discharge was taken from a positively or negatively charged body.

Prof. W. G. ADAMS considered Prof. Thompson's experiments to be most interesting, and they would be of the very greatest importance if they led to an explanation of the greater ease with which a negative charge escapes compared with a positive charge.

INSULATION IN MARINE WORK.*

The secret of all success in electric lighting, and especially aboard ship, is a good, durable, and well-protected insulation. In the early days this fact, if recognised, was not fairly considered. To-day, and thanks in a large measure to the office of the Naval Inspector of Electric Lighting, established in 1887, not only the installations in the cruisers now building, but from competition amongst manufacturers, drawing their inspiration from the requirements of that office, commercial plants as well, give evidence of increased excellence in this regard.

It does not seem to be difficult to manufacture an insulation that will answer all requirements when new. The great trouble has been to obtain durability when subject to the varying conditions of heat and cold, dryness and moisture, and the rough treatment incidental to use aboard ship. Vast quantities of materials have been brought into requisition, such as resins, which are usually too brittle, or when mixed with tar too easily softened by heat, allowing the conductor to sink through; asphaltum and bituminous compounds, which have been favourably mentioned; tar and pitch, not regarded as trustworthy when used with rubber or gutta-percha, the latter suffering injury from the action of the solvent oils; paraffin, which shrinks on cooling, and tapes soaked in the latter, which are rotted by the free acid; asbestos, which resists heat and the action of acids, but absorbs moisture; ozokerite, a crude native paraffin, originally like petroleum, but from which the more volative components have escaped, found in Galicia, lately in Utah, applied in various ways to rubber, supposed to shorten the life of the latter; cotton, silk, flax, and jute, with or without shellac or paraffin, which do not withstand changes of temperature or moisture; gutta-percha, better than most of the above, but must be kept under water or at a uniform temperature, hence, unsuited to ship's use; and lastly, indiarubber, well-nigh universally recognised as the most desirable material, but on account of its comparatively high cost not used to a considerable extent in its pure state, but more or less adulterated with many of the above-mentioned substances. In this brief list no mention has been made of the numerous patented compounds, which possess greater or less excellence according to the cost and care of their manufacture and the use for which they are designed, but it is safe to say that not one of them equals in insulating properties and durability, under the changing conditions, pure indiarubber, but in the struggle to obtain a cheaper commercial article approximates to it in excellence more or less in the ratio of its cost.

The qualities recommending pure rubber are its high insulation, its durability, flexibility, elasticity, its power of withstanding changes of temperature and moisture, and its immunity from the harmful action of most acids. There are, of course, cases in which it is not necessary to use pure rubber for the whole thickness of the insulation. For large conductors, such as are used for electric lighting, it is sufficient to have a layer of pure rubber to begin with, and vulcanised rubber compounds and tapes outside. In all cases it is necessary to prevent access to the copper of the sulphur of vulcanisation, as the former would be thereby soon attacked and corroded. Likewise the pure rubber must be protected from any possible heating of the conductor when accidently traversed by strong currents. These objects are attained in the best wire of to-day, as follows:—The copper strands are covered with a heavy, smooth, and a uniform coat of tin. The latter metal resists most of the chemical actions that would injure the copper. The conductor, of a single or several twisted strands, is then wrapped with a thoroughly dried cotton parcelling, or is braided with cotton, and is soaked in a pure rubber solution. After that comes a ribbon or sheet of pure rubber, technically called brown rubber; then a layer of rubber containing no sulphur, usually mixed with zinc oxide, and called the white rubber or separator; then a layer of vulcanised rubber, called black rubber, or a layer of Okonite, and lastly, a cotton parcelling, or preferably a braiding, soaked in ozokerite or some insulating compound. A disadvantage of having cotton next the wire is that it collects moisture. This may be prevented by having it thoroughly dry when put on and applying the pure rubber at once in a dry atmosphere. An incidental advantage is that it keeps the surface of the wire clean and bright. The real reason for its use, however, is that it keeps the pure rubber from softening when the conductor is overheated. Para rubber is the best and purest form in use, and is stipulated in the latest navy contracts. The outer layer is vulcanised to render it more durable, and the white rubber separator prevents the sulphur from penetrating. A lead covering is now generally used in ship lighting. It must be pure and soft to stand bending, and thick enough to resist abrasion. Its object is to prevent access of salt water to the conductor, and to permit the whole system to be made water tight. An incidental advantage is that it prevents to a great extent the drying and cracking of the insulation. Tin is sometimes alloyed with the lead in underground conductors, and is said to render it less liable to oxidation and pitting. A covering of jute gives it additional protection.

It is not to be supposed that such insulation as this was manufactured a few years back. It will be interesting to follow its development as shown in plants so far installed in ships of the navy. The "Trenton" was the first man-of-war lighted by electricity, and was installed by the Edison Company in the summer of 1883. The specifications required that the conductors should be of the most improved pattern used by the Edison Company for isolated lighting. The present inspector of electric lighting supervised the installation in a general way and served as executive officer of the ship during the ensuing cruise. The company, however, was primarily responsible for the material, having ample latitude under the contract. It is safe to say that they supplied the best insulation at that time to be had in this country, though fears were entertained of its ultimate adaptability to the requirements of shipboard. The conducting mains were of a single strand of copper in two sizes, Nos. 12 and 14 B.W.G. The larger wire was covered with three braidings of cotton, the inner one soaked in bituminous compound, and the outer one painted. The smaller wire was wrapped with cotton thread, soaked in a compound, then braided with cotton and painted. Neither of these insulations proved efficient. The first answered fairly well, but principally owing to the protection afforded by well-painted wooden mouldings enclosing the wire. The second frequently gave out, softening, and allowing salt water to reach the wire. The branch wires for single lamps were of two sorts, both No. 18 B.W.G., one tinned and rubber-coated, the other similar to the No. 14 above. The rubber was of poor quality, broke off, and did not stand heat. The coating of tin, however, prevented the access of salt water and consequent corrosion. On that account it was recommended in the future to tin thoroughly all wires for ship lighting. The other branch wire proved worthless, and had to be replaced during the cruise. The vicious effects of salt water seemed so apparent that a lead covering for all wires was recommended. Thus it is seen that this plant, while in the main successful, afforded valuable lessons for future guidance.

It will be proper here, in point of time, to mention two installations,

* From the *Electrical Review* of New York.

Digitized by Google

both by the Edison Company, which, while intended to be the best, were not directed by the Bureau of Navigation, and were not on the lines of the experience gained in the "Trenton." The first was the "Dolphin," in the summer of 1884. The building contract required her to be lighted by electricity, and the contractor was at liberty to select any system. The conductors employed were of copper, tinned, insulated with rubber tape. In the smallest size a painted cotton covering took the place of the rubber tape. Mouldings were not generally used, but in some cases a light batten was employed for appearance or for protection from salt water. This type of conductor has proved fairly satisfactory. In some cases water has reached the wire with the usual corrosive effect, though the faults were stated to be due to improper leads and carelessness in wiring rather than to the character of the insulation. It was recommended to paint the parcelling.

The other installation referred to was that of the "New Hampshire," in the autumn of the same year. Her mains were of No. 16 double conductor wire. Each strand was first parcelled with cotton and served with thread, and the whole soaked in melted paraffin. The two were then wrapped together with rubber tape and thread and again paraffined. The idea of this poor insulation of the mains from each other was that in case of a fault or short circuit, before the current could do much damage, the insulation would be heated and perforated, the conductors would come together, act as a fuse, and the circuit would be broken. This system was not successful in practice. Safer and more economical means can be devised to accomplish the same end. For the branch leads, two sizes of wire, Nos. 17 and 18 B.W.G., both tinned, were employed. The former was rubber insulated and parcelled with tape, and proved the most satisfactory of the installation. The other was insulated with gutta-percha, which, as has been seen, does not stand change of temperature, is brittle when cold, cracking and breaking, and soft when hot, allowing the wire to sink through. No mouldings were used; salt water penetrated the insulation and corroded the wire. The double conductor mains were shortly replaced by torpedo wire. In the spring of 1888 the ship was entirely re-wired with Okonite wire laid in wooden mouldings. It is reported to give satisfaction.

In the summer of 1884 specifications were got out for the "Atlanta," "Boston," and "Omaha." They were identical in requiring the conductors to be of copper wire, tinned, insulated, and laid in pure lead tubing. The "Omaha," installed by the Consolidated (Sawyer-Man) Company, was the first completed, in the spring of 1885. The two sizes of conductors were used, Nos. 6 and 16 B.W.G., consisting of a single strand of copper, tinned, insulated with two layers of cotton braiding soaked in paraffin and lead-covered. They were secured by iron staples and were generally without the protection of moulding. The first reports on this wire were favourable. In the latter part of 1887 leaks were first noticed, the lead having been found cracked and the wire corroded. In the beginning of 1888 the ship was recommissioned for another cruise and large quantities of new material sent out to replace the old. The new wire was rubber insulated, lead covered, and similar to the best samples of the time, to be described later. In regard to the old wire then in the ship, that on the spar-deck and engine-room circuits was described by the officer in charge of the plant as completely useless. The lead covering had been cut through by the staples, the cotton insulation rotted by salt water, and the wire grounded. It was considered that a lead covering, on account of the facility it afforded for grounds, was not desirable except with perfect insulation, and iron staples, it was thought, should never be used. In the latter installations the practice has been to use a flat fibre staple to secure the lead-covered wire in the mouldings. The material is tough and elastic, and is not affected by salt water. Specially devised instruments are employed to puncture holes for them in the wood and to set them home; they do not stand driving with a hammer. The driving tool should be constructed in such manner as to prevent setting home too hard and thereby cutting the lead.

Next we come to the "Atlanta," installed by the United States Company (Weston system) and finished in the autumn of 1886. Two sizes of wire were used, Nos. 10 and 18 A.W.G., each a single strand tinned, wrapped with thread, covered with a preparation of rubber, a paraffined braiding, and a lead coating. This wire answered for a while. The first report of broken lead, entrance of salt water and corrosion was in the second quarter of 1888. The trouble occurred in the after orlop, though other portions must have been more exposed. It is an instance of how salt water finds its way everywhere. Portions of this wire subjected to continuous heat over the wire gave evidence of a thorough baking and disintegration of the insulating materials. The process of vulcanisation is apt to go on under these circumstances till all the rubber is a solid mass. The separator and pure rubber must be depended on to stop the injurious action. In 1887 samples of Okonite wire, with and without lead cover, were received for trial. These samples were of the same size as the original conductors, had a layer of Okonite next the tinned wire, and a braiding soaked in an insulating compound.

The "Boston" was installed by the Brush Company, and finished in the spring of 1887. The wire supplied was like the "Atlanta's" in every respect. In the third quarter of 1887 it was reported that salt water got to the wires where passing through the steel decks. Bad insulation was assigned as the cause. During the installation of these two ships they were inspected from time to time by the present naval inspector, though the specifications and contracts were made before the establishment of his office. Their plants were certainly superior to any previously installed, and, in spite of the faults enumerated, fairly efficient.

The next wiring to be considered is that of the "Chicago," installed by the Edison Company, contracted for in December, 1886, and finished in the spring of 1888. The specifications required that the conducting wires should be tinned, covered with the best rubber insulation, and enclosed in pure lead tubing. A sample of not less than 500ft. in length should, after at least 24 hours' immersion in sea water, possess an insulation resistance of not less than 1,000 megohms per nautical mile. The conductors were of various sizes from No. 6 to No. 16, and of a single strand of copper, tinned, insulated with the white and black rubber tape, and enclosed in a lead tubing. It was found on wiring that the larger sizes were not flexible enough, and the lead cover, from insufficient thickness, sometimes broke in bending. These two faults have been remedied in later specifications by requiring all large conductors to be stranded, and the lead cover to be at least 0·04in. in thickness. Another advantage in stranded conductors, in addition to greater flexibility, is that all the wires are not apt to be broken together, the breakage of one or two not being fatal. But if a single conductor parts, the circuit is broken and the fault is harder to repair, if indeed it is not entirely concealed by the insulation. Lighting companies were, on account of the increased cost, loath at first to make this change, but the advisability has now been generally recognised. The "Chicago's" plant has been in frequent operation for considerable periods, and has proven satisfactory. No opportunity has been afforded of testing the insulation in actual service at sea, but it is thought that it will fill the requirements. This was the first instance of stipulating a definite insulation resistance in the specifications. It is now a feature of all contracts.

The re-wiring of the "Trenton," likewise by the Edison Company, dates from that time. Contracted for a few months later than the "Chicago," she was finished nearly a year earlier. The specifications were in the main similar, but there was the additional requirement that no conductor should contain a wire of greater diameter than a No. 16 B.W.G., but that the necessary area should be made up of smaller wires, in order to produce flexibility. The "Trenton" being a wooden ship, the bureau was of the opinion that with a good rubber insulation a lead tubing would not be necessary. The requirement was therefore omitted. The wire was manufactured by the India-Rubber and Gutta-Percha Insulating Company, of New York, the same firm that had supplied the Edison Company with the wire for the "Chicago." The mains of the "Trenton" were of two sizes, using seven strands each to No. 16 and No. 18 wire respectively, or, as they are denominated technically, $\frac{7}{16}$ and $\frac{7}{18}$. The branches were a single strand, No. 16. The leads from the dynamo to the switch-board had a core of seven $\frac{7}{16}$ cables twisted together, making in all 49 strands. These conductors were all tinned, parcelled with cotton soaked in a rubber solution and insulated with layers of brown, white, and black rubber successively, and, lastly, a parcelling of rubber tape. The reports received from this ship were in the main satisfactory. Her unfortunate loss at Samoa has made it impossible to know how the insulation would have stood the further test of time.

The "Yorktown" is the last ship installed, and involves all the improvements suggested by previous experience. The contract was sublet by the builders to the Edison Company on specifications drawn by the Naval Inspector. The part relating to the character of the insulation is quoted in full. All conductors, except fixture and portable wires, shall have:—(*a*) A layer of fine braided cotton; (*b*) a layer of rubber, containing no sulphur; (*c*) a layer of vulcanised rubber or Okonite; (*d*) a parcelling of rubber tape; (*e*) a waterproof covering of pure lead not less than $\frac{1}{16}$ of an inch thick. The installation, exclusive of cotton and lead, shall not be less than $\frac{7}{32}$ of an inch thick. It shall, after 24 hours' immersion in sea water have a resistance of not less than 1,000 megohms per nautical mile. . . . A sample of 500ft. of the regular pattern of conductors to be forwarded to a place designated for testing.

The physical characteristics of the insulation shall not change when the conductor complete is raised to the temperature of boiling water nor upon cooling.

Insulation, when complete, with all connections made ready for the use of each and every lamp, the insulation of the entire system of conductors, including the circuits of the dynamo, shall not be less than 1,000 ohms of resistance to every volt of electromotive force of the dynamos. The outer coating of all conductors, all fixtures, junction boxes, switches, receptacles for portables, and all other exterior parts of the system, shall be insulated from the ship. All junction boxes, switches (unless otherwise designated), conductors, joints of conductors, and entrances to fixtures, shall be water-tight). The interior insulating block of junction-boxes and water-tight switches and the bases of other switches and receptacles, also the switch-board, shall be of porcelain, slate or marble.

In making this wire the manufacturers applied first a layer of pure Para rubber over the braided cotton, which was beyond the requirements of the contract, and then the other layers as above enumerated. The conductors were accepted after a number of tests, which were deemed satisfactory. It is too early yet to make predictions, but in two or three months' use there is absolutely no fault to find with the character of the insulation.

The wire supplied the "Pensacola," the "Charleston," and the "Baltimore" is similar to that of the "Yorktown." The dynamo leads are now made in a single cable of the requisite number of strands, instead of a number of seven-stranded cables laid up together, as furnished the "Trenton." On account of the difficulty of braiding over a number of loose strands, a parcelling of cotton is used next the wire. This answers the requirements equally as well. An improvement has been made in the matter of the outer parcelling, which in some cases worked loose in bending, by substituting for it a close braiding of cotton, and soaked in ozokerite.

The flexible conductors for portable lights are of an improved form, suggested by gradual experience, and will be briefly mentioned. The double conductor form seems to be the most desirable when sufficiently flexible, as it is less likely to kink than the separately insulated and twisted strands. It was made at first with an inner stranded conductor, and the strands of the outer one disposed at intervals about it. An extra strand was put in the outer conductor to provide increased cross section and compensate for the extra resistance due to the greater length of the outer-spirals. When these were tried in the "Yorktown" it was found

Digitized by Google

that the outer strands, receiving no mutual support, were apt to be broken by the continual bending at the point of entering the fixture or plug. A new form, now on trial, contains two stranded conductors insulated and laid side by side, with jute fillers to give a rounded cross-section, and a double hemp braiding soaked in ozokerite laid on all over. The resulting wire is flexible, and bids fair to answer well. For use in cabins and officers' quarters, a braiding of floss silk has been employed instead of the hemp. Lately, twilled silk has been substituted, making a smoother and more durable finish. For fixtures that will not admit the regular branch leads, a small stranded conductor is used. The core consists of three No. 25 wires, tinned, insulated with white rubber, vulcanised rubber, and a fine cotton braiding soaked in ozokerite.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *January* 18, 1890.

The Proposed New Board of Electrical Control.—In regard to the underground question in this city, it looks as though it would soon be a case of "The king is dead: long live the king!" The term of office of the present Board of Electrical Control expires by legal limitation next November, and already steps are being taken to provide a successor. Under the present law its duties devolve on the Sinking Fund Commissioners of the city, for what reason I can hardly say, unless it be one derived from a play upon words. The nature of the Board which is to take the place of the old one is now a matter of a great deal of discussion and consultation among the politicians of this city and at Albany, and it is already pretty evident that politics will be mixed up with the next Board much as they were before. The Subway Board Bill, which has been introduced into the State Senate this week, provides that it shall consist of three Commissioners, only one of whom shall necessarily be versed in the science of electricity, the other two being by specific provision not less adept in the science of politics. In other words, the Board is to comprise one Republican, one Democrat, and one electrician. These Commissioners are to be appointed by the Governor by and with the consent of the Senate. They are to hold office for five years, and receive a salary of $8,000 a-year, with travelling expenses. They are to have a chief clerk and a secretary, also appointed by the Governor, and this secretary shall be an executive officer. It does not particularly matter whether he knows anything about electricity or not, but the Bill is careful to stipulate that his politics shall be different from those of the expert. This plan is regarded as the best to ensure the non-partisan character of the Board, and to bring it up to that high level of purity which distinguishes politics generally in this state. One thing noticeable about this Board is that its functions are far more general and comprehensive than those of the old Board. It is to be endowed with powers similar to those of the Railroad Commission, such as administering oaths, investigating accidents, and the like, and is given general supervision over all the telegraph, telephone, electric wires, motor, subway conductor or conduit associations, companies or corporations, and all corporations and associations that in any way "utilise the electric fluid" for the public use or for the purpose of commerce. In other words, the Board is to have the general supervision of the whole electrical business in this state, and it is further charged with the responsibility of seeing that no exclusive privilege or franchise be granted to any corporation, company, or association or person by which a monopoly shall be created or competition shall be prevented. It is possible that this Board may confer some benefits upon the electrical industries of this state, but the measure is evidently one that it will pay all electrical interests to watch closely lest it bring on the whole commonwealth the evils which up to the present time have been the peculiar property of New York City.

The Board of Health and High-Tension Circuits.—An attempt which has just been made in this city to compel the Board of Health to interfere to prevent the operation of high-current circuits has just been defeated. A mandamus was asked for to compel the Board to remove from the streets high-tension wires, but the judge has denied the application on the ground that the busybodies who have interested themselves have no clear legal right to attempt what is asked for. The judge is of opinion that the Act which established the Board of Electrical Control took away from the Board of Health all power in respect to electrical conductors in the city of New York. There is much satisfaction felt generally at the defeat of this little movement, because it is considered that the object in view was not to protect the public health and welfare, but merely to promote commercial ends and to gratify commercial antagonisms. It is to be feared that half the trouble from which we have suffered in New York, and from which, as a result, the electrical interests elsewhere have suffered generally, have arisen from attempts which it would be hard to define in language otherwise than libellous, if we admit the proposition that "the greater the truth the greater the libel."

The Boston Public Lighting Contract.—The situation in Boston at the present time is one of more than local interest. For a long time past the city lighting there has been done by the Boston Electric Light Company, which has received on an average about 50 cents a night for a full 2,000 c.p. arc light. Proposals being invited for new bids, various tenders were made, and the contract has now been taken away from the old company and awarded for the most part to the Suburban Light and Power Company at a rate below 40 cents. per light. The remarkable thing about this is that while the Boston Electric Light Company is an old-established concern that has about a million and a-half dollars invested in its plants and circuits, which ramify all over the city, the Suburban Company have neither plant, nor location, nor circuits; and the result is that, although the new contract represents an apparent saving to the city of about $75,000, there is a good deal of local feeling with regard to the stringing of several hundred miles of new high-tension wires through the streets and over the buildings. The fire underwriters have protested against this, and several real estate owners have joined in opposition. There is more in this controversy, however, than appears on the surface, or in the facts thus far detailed. The root of the whole matter is the competition between the Thomson-Houston and the Westinghouse companies. The old company is friendly to the Thomson-Houston interests, and largely uses the Thomson-Houston apparatus. The new Suburban Company is understood to have Westinghouse interests behind it, and it is said that all the apparatus for the new work has already been ordered from Pittsburgh. Yet another point of interest occurs in connection with the rumour that it is the intention of the Westinghouse Company in carrying out this contract to use its new alternating-current arc lamp, through the introduction of which it claims to secure greater safety for those handling the lamps, and greater economy in the consumption of carbons and the operation of the circuits.

Electric v. Cable Street Railways.—For some time past it has been generally and frankly admitted by street railway men that the horse and the steam engine cannot enter seriously into competition with electricity for the propulsion of street cars. In other words, the competition has narrowed itself down to the cable and the electric motor in the larger cities, the smaller cities being considered at all events the legitimate and proper field for the introduction of electricity as a motive power. The cable interests have been making an ardent and strenuous fight for the maintenance of their grip upon and in the larger centres of population; but it begins to look as if they were losing their hold even there. Thus, for example, the news comes this week from Minneapolis, one of the most beautiful and progressive cities of the country, that the street railway company there has abandoned its intention to equip its system with cables, and now intends to use electric cars, for which it will equip 100 miles of its track throughout the city. What gives the change a greater significance is the fact that the street railway company had already actually bought and accumulated $400,000 worth of cable plant. In view of the advantages to itself and to the public which it plainly sees can be derived from the use of electricity, it has thrown aside all this cable plant, which can now be bought for scrap-iron, and is devoting its energies to the speedy equipment of its system with electricity. The sister city of St. Paul is to follow its example.

Digitized by Google

Instances of this kind are worth volumes of argument, and they are at the same time an adequate confirmation of all the claims the advocates of electricity have maintained for it as the ideal motive power for street-car operation.

Duplex Telephony.—The recent issue of a patent for a method of duplex telephony to Dr. Rosebrough, of Canada, has called forth an article from the pen of Mr. John A. Barrett. This gentleman has had considerable experience in telephony, and especially in the branch relating to long-distance work and duplexing, having until recently occupied the position of electrician to the American Telegraph and Telephone Company, who operate the long distance lines in this country. Notwithstanding the work done on duplex telephony in the past, Mr. Barrett claims—and he, by the way, is also the patentee of one of these devices—that there is still to be offered publicly a reasonable method for multiplying the number of telephone communications upon a single line, *i.e.*, obtaining a true duplex, as in the case of the telegraph. The nature of the telephonic impulses, according to Mr. Barrett, are such that we have not yet been able to devise instruments which would differentiate between two individual messages at the transmitting station, and sift out the same at the receiving station, and hence the enormous difficulty of the problem becomes apparent. Mr. Barrett then points out what has been done in duplex telephony, and cites the "bridge" method, in which two wires are used on a single metallic circuit, and this pair again used as a single line forming a part of another circuit. This forms the principal feature of the patent issued to Mr. Frank Jacob, and in which Mr. Barrett seems to find the fundamental principle of all duplex telephony schemes so far proposed. Thus, according to the present methods, the best that has been accomplished has been the reduction of the number of circuits by one less than the number of messages to be transmitted. Mr. Barrett, however, refers to the fact that by the application of the Jacob patent to the "bridge" method the lines can be used for simultaneous telegraphy without in any way interfering with telephonic transmission. But the reason why this has not been applied in America may be looked for in the fact that the Jacob patent is owned abroad.

Improvements in Quadruplex Telegraphy.—As your readers may be aware, the same difficulty is still experienced in the operation of the quadruplex telegraph, and in seeking to overcome these Mr. Clarence L. Healy, one of our brightest telegraphists, came to the conclusion, on a thorough analysis, that much of the difficulty was due to the high resistance of the local circuits, including that of the battery. Our ordinary quadruplex lines have a line resistance of about 3,000 ohms, but when it has an artificial line attached to it through the differential relays to balance it, the joint resistance offered to the battery current is about 1,500 ohms, and when 300 cells of a gravity battery are connected, as they usually are, by the second side transmitter, the actual potential which reaches the line is that which arrives at the joint lines due to the fall of potential in the battety itself. These 300 battery cells measure 900 ohms or more, and hence the loss in the battery will be in the ratio which this battery resistance bears to the joint resistance of the line, which usually brings it down to one-third in clear weather. It is evident that in bad weather the heavy leakage greatly reduces the percentage of current which is available for the line. Upon the introduction of the dynamo quad in this country, this objection was slightly overcome by the lower artificial battery resistance used between the dynamo and pole changer, being usually two ohms to the volt. But this still caused a large percentage of loss, this high resistance being used in order to prevent the burning of the contact points of the "increasing" transmitter. All these difficulties have been overcome by Mr. Healy, by a new arrangement of the relay and connections. With this relay and local arrangements, briefly, all condensers, induction coils, and extra magnets to "kick" the current through, either winding on the relay, or extra magnets to hold the armature steady at reversals for preventing the mutilation of signals, are done away with. Again, the resistance of two ohms to the volt formerly employed has been similarly replaced by a short fuse wire, which acts admirably, and in fact is a better safeguard against abnormal current than the resistance. Thus, by removing all extraneous resistance, and the avoidance of the retarding effects of induction coils, the practical operation of the system has been very much simplified. Mr. Healy has worked long lines on this system for several months past with excellent success in all weathers.

PARIS NOTES.

(FROM OUR CORRESPONDENT.)

January 27, 1890.

As I mentioned in my last letter, the Commission Technique met on the 15th inst. to consider the proposal of the Conseil Municipal that the members of the Commission should ascertain whether or not all the plant installed at the various central lighting stations in Paris was of French origin. M. Paulard, the originator of this demand, was called upon by the members of the Commission Technique to explain exactly what was wanted by the Conseil Municipal, and his interpretation of the resolution passed at the meeting of this body at the beginning of the year was that the Commission Technique was merely asked to make sure that all the plant bore French marks. A report was subsequently received from the Superintendent of Works to the effect that M. Victor Popp alone employed foreign plant. M. Popp's reason for this delinquency was that, unless he went to the expense of erecting special machinery, it was absolutely impossible to obtain the engines he wanted anywhere but abroad. A striking instance, I think, of the absurdity of this crusade against foreign material.

The Commission Technique, charged with the duty of testing the electricity meters sent in to compete for the prize offered last year by the Conseil Municipal, has terminated its labours, at any rate for the present, and will shortly publish its report. I understand that only half the sum allocated for this purpose by the authorities will be divided among the four or five most meritorious meter makers. The reason for this is not that the meters have given poor results, but that since last May, when the time for entries closed, remarkable improvements have been effected in this direction. It is therefore proposed to inaugurate a fresh competition, and the regulations with regard to it will shortly be made public.

At a meeting of the Association Philotechnique last Friday, M. Laffargue, engineer to the station at the Halles, gave some interesting particulars relating to the erection and working of the municipal electric lighting works. He explained, amongst other things, that the price per kilowatt-hour was fixed at 1fr. 50c., in order not to undersell the various companies who had obtained costly electric lighting concessions from the authorities, although, as a matter of fact, the cost of production was only 70 centimes.

There is considerable talk in electrical circles of a new continuous-current machine of MM. Reignier and Bary, the output of which weight for weight is stated to be ten times as great as that of the best dynamos hitherto constructed, and the cost of which is consideraly less. An official test of the new machine will be made in a day or two, and I hope in my next letter to send you some further particulars.

The electric traction experiments on the Madeleine-Levallois line still continue, and it is rumoured that the tramway company contemplate taking out a licence from the Société Française d'Accumulateurs Electriques. I may mention in this connection that the Compagnie des Tramways Sud have laid a proposal before the authorities that boxes should be placed on their cars in which telegrams may be posted by the inhabitants of the suburbs, these telegrams being given in by the tramway officials at the nearest telegraph office. At Brussels, where the suburbs are as badly off for telegraphic facilities as at Paris, this system has been in successful operation for the last fifteen years.

CORRESPONDENCE.

THE "COUNTER ELECTROMOTIVE FORCE" OF THE VOLTAIC ARC.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: We hear a good deal about a so-called "back electromotive force," or "counter electromotive force," in the voltaic arc, and a great number of experiments have been made to measure what I believe to be a purely imaginary quantity. These measurements all assume that Ohm's law is true for the discharge in the arc; but we know that Ohm's law does not hold for gaseous discharges, and, as far as I can see, we have no

Digitized by Google

independent evidence at present of the existence of any such thing as a counter electromotive force.

Let us see what our measurements can give us. We can ascertain the difference of potential between the carbon poles, or even between any two points in the arc itself. We can also measure the current, and a combination of the two quantities can give us in a given case the relation between the fall of potential and the current: but nothing more than that. We may, if we like, call the ratio of the electromotive force to the current "resistance;" but we have no right to assume that the resistance so defined is independent of the strength of the current or proportional to the length of the arc. Yet this assumption is made wherever the "counter electromotive force" is supposed to be measured.

The measurements are conducted in one of two ways. If E is the difference of potential between the two poles, C the current, and e an assumed counter electromotive force in the arc, we may write $E = C R + e$.

Now, if it be assumed that R follows the same laws as in a solid conductor, we can obtain a second equation by varying the current, leaving the carbon poles as they are, and considering R constant; or we may lengthen the arc and take R to be proportional to the length of the arc. If a second equation is obtained we can calculate e; but, as already pointed out, everything rests on the assumption of the truth of Ohm's law: without that assumption we can gain no information as to e.

Let us go a little further and see what evidence would be necessary to prove a counter electromotive force. If E is the electromotive force between equipotential surfaces of a discharge of any kind, the work done in unit time is E C. If this work appears as heat there is no more to be said about it, but if the actual heat generated is less than E C, some other work must be done, and if that other work is proportional to the current we should have a right, and probably find it convenient, to speak of a counter electromotive force. In an electrolytic cell, for instance, we could in this way determine the electromotive force of polarisation. It seems to me that only when work is done by a current independently of the heat generated by resistance, that we have any reason for speaking of a "counter electromotive force." Such work may possibly be done in the arc. We have in the first place the disintegration of the poles, and have certain chemical actions between the poles and the air. Owing to such work, it may ultimately be found necessary to speak of a counter electromotive force. At present the term seems unnecessary. I believe that a great deal can be found out by a scientific investigation of the voltaic arc, but some of the work which has been done is almost rendered useless by the assumption of the truth of Ohm's law in cases where it does not hold. If investigators were to give their results simply as an experimental relationship between current and electromotive force much more good would be done.—Yours &c.,

ARTHUR SCHUSTER.

THE CLARK STANDARD CELL.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As the Clark standard cell is now being discussed in the columns of *The Electrician*, I send you the following notes of some recent experiences in the laboratory of these Schools on the change of colour of the mercurous paste referred to by Lord Rayleigh in his article on p. 285.

The paste we used was made from materials supplied by Messrs. Hopkin and Williams—the source, if I remember aright, mentioned by Lord Rayleigh as that from which he obtained the mercurous sulphate used by him.

Soon after mixture the colour of the paste began to change, becoming first yellow, and then, as successive additions of zinc carbonate were made, darker and greener, until after long standing it was quite a dark green. The quantity of zinc carbonate added was very large as the paste kept up a slow effervescence for a very long time.

It was at first supposed that this change of colour was due to the presence of mercuric compounds, together with free acid. Careful tests failed, however, to reveal any perceptible proportion of any mercuric salt, but a very considerable quantity of iron was found to be present in the form of a salt soluble in cold water, probably ferrous sulphate.

By repeated decantations with cold distilled water the iron salt could be washed out of the mercurous sulphate until chemical tests revealed only a very minute residual trace. The water used in the washing, after standing for some time in glass vessels, deposited a yellow incrustation on the sides and bottom of the vessels. The washed salt, when mixed with the zinc sulphate solution, retained its greyish-white colour even after the addition of zinc carbonate in some quantity, although the absence of any effervescence removed the necessity for the addition of the latter. Some paste made from the washed salt has now been in the cells for more than a month and is still as white as at first.

Those cells which were made up with the first and impure paste have, as might have been expected, turned out useless and have been pulled to pieces again. Those made up with the washed salt are now undergoing tests by the students in the laboratory and seem so far to be perfectly satisfactory in their behaviour, the only trouble with them being the greater difficulty of ensuring the complete saturation of the paste.

It would seem from this that the change of colour and deterioration of the paste were due to the presence of the iron impurity in it. But whether the whole effect is to be put down to this cause is not very certain. In washing other portions of the same sample of mercurous sulphate it has been twice noticed, once by myself and once by one of the students, that after the salt had received such a number of decantations that presumably all traces of iron were washed out, on the addition of a fresh bulk of distilled water the salt rapidly and unaccountably assumed a light yellow tint which persisted with further washing. What this is due to I do not yet know: possibly the purity of the wash water may have something to do with it, for if ordinary tap-water is used in the washing the iron is thrown down and the salt quickly changes colour. Those portions of the salt which were thus changed were rejected in making up the cells; the rest, and by far the greater bulk of the washed salt, remained quite unchanged.

H. H. HOFFERT.

Physical Laboratory, Science Schools,
South Kensington.

"ADVANCES IN MAGNETISM."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I cannot understand Mr. Esson's objection to the term magnetic resistance, as the analogy appears to me to be very complete, the only difference being that, in almost all substances except iron, $\frac{H}{B}$ is a constant, while under working conditions with nearly all conductors of electricity $\frac{E}{C}$ is a variable. For instance, in the case of an incandescent lamp, $\frac{E}{C}$ is certainly not a constant. Again, it is possible so to proportion an iron wire resistance that, although it only takes about 10 per cent of the power when in series with an arc lamp on a constant volt circuit, yet when the arc is short-circuited, the current only increases by about 20 per cent.

Mr. Esson apparently forgets that, when he is calculating the saturation curve of a dynamo, by far the greater part of the work is to calculate the resistance of the magnetic circuits whose lines do not pass through the armature: these almost all pass through the air, in which case $\frac{H}{B}$ is a constant as far as we know.—Yours, &c.,

H. W. RAVENSHAW.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: May I be permitted to trespass a little on your valuable space by offering a few remarks on the subject of the letter from Mr. Esson, published in your last issue?

The objections put forward in that letter to the term *magnetic resistance* and to an Ohm's law analogy appear to be based upon the supposition that, whereas the property of iron in question *is not* constant for all values of magnetic induction, the resisting property of an electric circuit *is* constant for all values of the current. Even were this a scientific statement of the

Digitized by Google

relative conditions of the two circuits, surely it would not constitute sufficient ground for objecting to the term *resistance* in either case.

But, strictly taken, the conditions are not so essentially different. The Ohm's law analogy is not so wide of the mark as would at first sight appear.

In an incandescent lamp, for instance, the resistance, when there is a large potential difference, is by no means the same as the resistance when there is a small potential difference. So in a magnetic circuit. The magnetic resistance, when there is a large magnetising force, is by no means the same as when the magnetising force is small: both vary. The causes of the variation may be widely different; nevertheless, both vary. We do not quarrel with Ohm's law, we do not object to the term *resistance*, when dealing with electric circuits, on the ground that, because the circuit gets hot, $\frac{E}{C}$ is not a constant. Why, then, should we deny the law, or the term, to the unhappy magnetic circuit, in which the analogous ratio $\frac{H}{B}$ varies also, but happens to vary a little more noticeably?—Yours, &c.

E. T. Carter.

The School of Electrical Engineering, 12, Prince's-street, Hanover-square, January 28, 1890.

THE USE OF THE TERM "ELECTRIC SPLASHES."

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Enclosed I send you a cutting from the *Glasgow Herald* of January 22nd: a most excellent paper generally. The extract shows well the danger of using unmeaning catch words, like "Electric Splashes," and unmeaning action suggestive of "throwing electricity."—Yours, &c., A Correspondent.

January 23, 1890.

The following are some passages from the *Glasgow Herald* article to which our correspondent alludes:—

Some years ago a controversy raged somewhat hotly with regard to the question as to the nature of electricity, whether it was a fluid in itself or merely a peculiar condition assumed by matter. . . . Prof. S. P. Thompson has just exhibited at the Physical Society some experiments which would furnish powerful arguments in favour of the fluid theory. He made use of the interesting Lichtenberg figures formerly employed in the lecture room, but not much known now. . . Prof. Thompson modifies the experiment by holding the Leyden jar firmly in his hand, and, as it were, throwing electricity from the charged knob at the disc, instead of rubbing the surface with it as is usually done. After doing this several times in front of different parts of the plate he again peppers it with the dust, and the result is seen in the presence of figures which do not at all resemble those of Lichtenberg, but rather look like the splashes from a heavily charged paint brush loaded with colour thrown on to the surface in the manner employed by bookbinders when producing the well-known mottled edges of books, or by decorators in imitating granite. The experiment is a novel one, and its exhibition created much interest on the part of the audience.

[We are afraid no amount of care in word choosing would prevent the non-technical press from making absurd mistakes.—Ed. *E.*]

UNDERGROUND MAINS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I have read with interest the article on "Underground Mains" in last week's issue. There is, however, one clause which might lead to unnecessary thinking and misconception. Near the bottom of page 286, the author speaks as follows:—"The wires being all straight and separate and *not* in the form of a *cable*." In his next clause, which I also quote, he says: "When wires of a greater length are required to be drawn in than can be done at once, they are drawn through a certain distance and then coiled up; the coil is next turned over and the *cable* drawn through a further section, and coiled up again." In his first clause he says the wires are not made up in the form of a cable, whereas in the following clause he speaks of the wires being drawn through in terms of a *cable*. The word cable is *not* in terms with the sense of the sentence, as he uses the word "*they*" are drawn through, which distinctly points out that the wires are drawn through; and as the author is describing the Post Office system of underground mains, a part of which is the wires being all straight and *not* in the *form* of a *cable*, it is rather misleading and contradictory when in the next clause he says the "*cable*" is drawn through. It will be also noticed that he frequently speaks of "wires" in these clauses, and not "cable." I think that the word "cable" in the last clause should be replaced by "wires." The sentence would then read, "the coil is next turned over and the *wires* drawn through a further section, and coiled up again."—Yours, &c.

Gerald St. John Day.

43, Polwarth-gardens, Edinburgh, January 29, 1890.

ELECTRO-MAGNETIC APPLIANCE FOR TURNING ON GAS-LIGHT.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Would any of your numerous readers kindly inform me as to the best appliance for above, with gas burner best adapted for same? Four lights; line wire 60ft.: how many No. 1 Leclanché cells would be required? Would one line wire do, using earth for return current?—Yours, &c.,

John F. Neave.

2, Catherine-street, Dundee, January 21, 1890.

SIMPLE WIRING EQUATIONS.

Many convenient sets of tables and rules have been issued during the last year or two for the purpose of facilitating wiring calculations, and the two simple equation rules, with table, given below are, we think, likely to prove of use. They are due to Mr. J. Sayers, of Derby.

Let l = length in feet of wire (positive and negative),
c = average current strength to be carried,
e = loss of E.M.F. in wire, which in equation (1) would be decided upon beforehand, and in equation (2) the quantity to be ascertained.

Then, if the size of cable required for a certain current and length is what is wanted, it is readily obtained by

$$\frac{l \times c}{e} = x \quad . \quad . \quad . \quad . \quad . \quad . \quad (1).$$

If the loss of E.M.F. in a cable already fixed or planned of certain length and current strength is required, it is given by

$$\frac{l \times c}{x} = e \quad . \quad . \quad . \quad . \quad . \quad . \quad (2).$$

The values of (x) for the best-known sizes of wire and cables are given below; they really represent the feet per ohm for the particular cable:—

Values of (x).

B.W.G. No.	B.W.G. No.	B.W.G. No.
18 = 215	7/15 = 3458	19/15 = 9385
16 = 393	7/14 = 4702	19/14 = 13095
7/20 = 870	19/20 = 2362	37/15 = 18276
7/19 = 1299	19/19 = 3527	37/14 = 24882
7/18 = 1612	19/18 = 4374	37/13 = 31826
7/17 = 2181	19/17 = 5919	37/12 = 41905
7/16 = 2750	19/16 = 7462	

For example:—Case 1: A corridor 100ft. long, average current 15 amperes: what cable is required to have loss of ·5 volt? Answer is (length = (100 × 2))—

$$\frac{(100 \times 2) \times 15}{\cdot 5} = 6000,$$

and nearest cable corresponding to 6000 in table is 19/17—cable required.

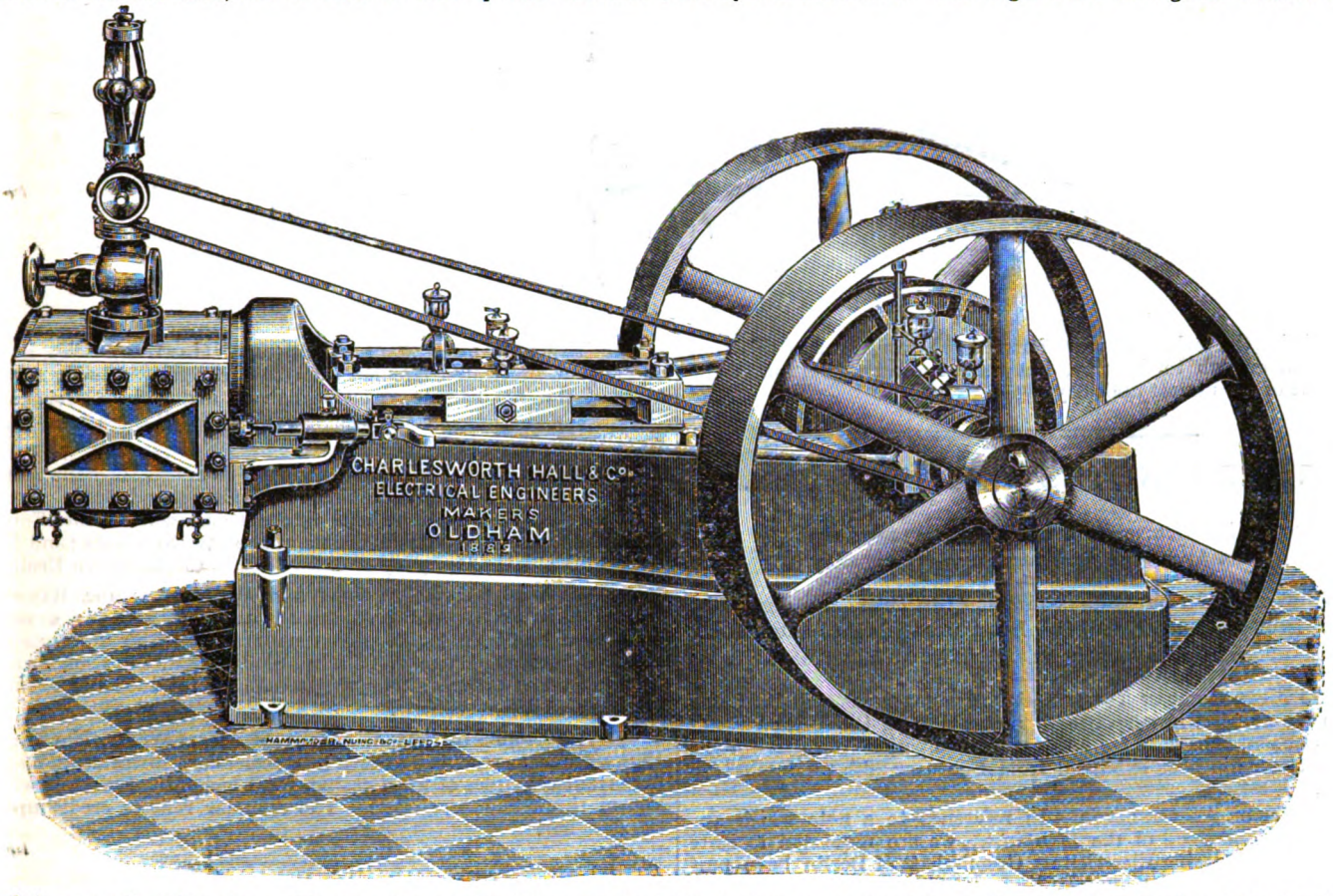
Case 2: A cable 200yds. long, positive and negative together, made of 19/18, carries average current of 7 amperes: what is loss from end to end? Answer: (19/18 = 4374 in table)—

$$\left(\frac{600 \times 7}{4374}\right) = \cdot 96 \text{ volt.}$$

Digitized by Google

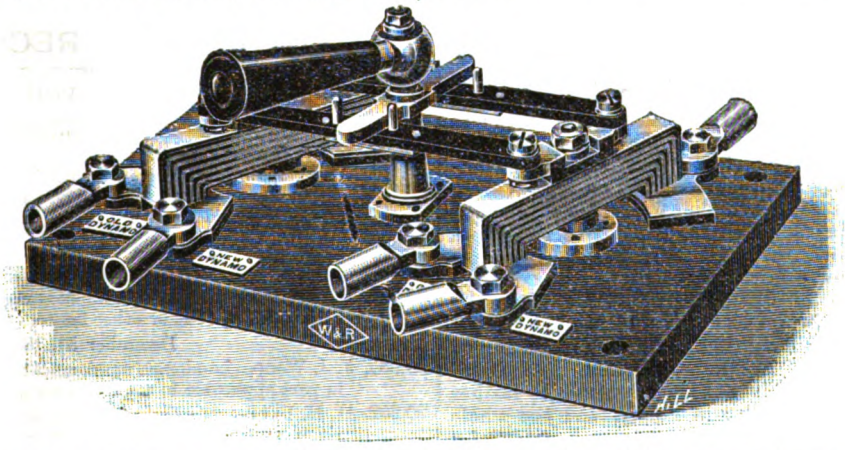
CHARLESWORTH, HALL, AND CO.'S ELECTRIC LIGHT ENGINES.

Our engraving shows a horizontal engine of a type lately brought out by Messrs. Charlesworth, Hall, and Co., and intended principally for driving electric light machinery. These engines are of massive construction, and having very stiff shafts and large bearings are capable of making long continuous runs. The cylinders have piston valves, lapped and ground, and in order to get a good opening to steam they are double ported. The crankshafts are of forged steel, and, as mentioned above, are exceptionally stiff. The crank webs are circular and have cast-iron balancing discs shrunk on to them. The slides are of the four-bar type, the bottom slides being planed on the bed itself, and in order to take up wear the slide block has an adjustable shoe. Wear on top can be taken up by letting down the top bars. The slide surfaces are very large, and so adjustment will very seldom be necessary. The piston rod is of hard steel, fixed by a cone and nut into the piston and cottered into the slide block. The valve rod is fixed permanently into the valve and has an adjustable joint into the guide, so that the valve can be adjusted without removing the valve chest covers. The connecting rod is adjustable at both ends. Pickering governors are fitted on the valve chest inlet. Automatic or hand expansion gear can, however, be fitted, if preferred. Careful attention has been paid to the question of lubrication, so that all parts can be lubricated whilst running. In order to balance strain on the crankshaft two flywheels are used. The engines are throughout finished in the best manner possible, and are giving much satisfaction in regular work.



THE WOODHOUSE AND RAWSON DOUBLE-POLE TWO-WAY SWITCH.

Our illustration shows a new form of switch, which is likely to find favour with those who advocate the double-pole arrangement of switches, and its construction contains one or two interesting novelties. It will be seen that the brushes are built up in a somewhat different way to the well-known multiple brush hitherto employed in switches of Woodhouse and Rawson: they are given a still greater individuality of movement by separating each part from the adjacent one with a washer in the centre, and for simplicity of construction they are made with square corners in place of round.

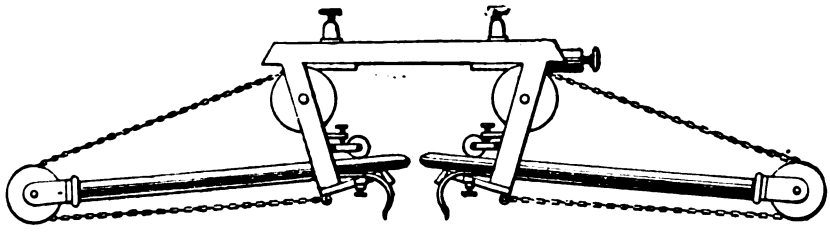


The cross-bars which connect the two brushes are of vulcanite, which possesses sufficient strength and the necessary elasticity and insulating properties. The method of attachment for the cables is the very convenient movable socket form into which the cable is sweated. The switch appears to be well designed for a class of work which is in common demand.

Digitized by Google

THE SOLIGNAC ARC LAMP.*

Among the many curious devices for bringing arc lamp carbons together, independently of the resistance of the arc, that proposed by M. Solignac is conspicuous. The apparatus is shown in the accompanying figure. The carbons are moved by an arrangement of drums and chains. A small glass rod is fixed underneath each carbon along its entire length. The end of each carbon is gripped between a roller and a support. To start the apparatus, the carbons are made to touch by turning a screw, and are then pulled apart, striking the arc. As the carbons are consumed the glass rods become soft, and bend over as shown in the figure, thus permitting the carbons to move forward. An apparatus of this kind is simple enough to describe, but the practical realisation of the same is of the utmost difficulty.



The Solignac Arc Lamp.

* Translated from M. Hippolyte Fontaine's "Éclairage à l'Électricité," by kind permission of the Author.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning.*]

We would refer our readers to some particulars relating to the 1890 issue of *The Electrician* ELECTRICAL TRADES' DIRECTORY and HANDBOOK, given on pages xii. and xiii. of Advertisements.

THE METROPOLITAN TOWER.—An announcement will be found on page xv. that in response to requests from the United States and Canada, the time for sending in competitive designs for the great tower has been extended from February 28th to March 14th next.

THE TUDOR ACCUMULATOR.—In reference to a note which appeared in our issue of the 17th inst., we are requested to state that the Allgemeine Electricitats Gesellschaft of Berlin have purchased the right of manufacturing the Tudor Accumulator, but have not purchased the Tudor Accumulator manufactory at Hagen, as incorrectly reported.

THE AMALGAMATED UNION OF ELECTRICAL OPERATIVES.—A notice is issued that the adjourned meeting of this Union, of which Mr. R. Steadman is secretary *pro tem.*, will be held at the Paul's Head, Paul-street, Finsbury, on Saturday, February 1st, at 7.30 p.m., "to further proceed with the rules and elect officers for the year."

MESSRS. J. G. STATTER AND CO. (LIMITED).—This firm write us as follows:—"Of the principal improvements in our manufactures made during the year 1889, the following may be noticed. For large machines for low and moderate tension, we have adopted the single circuit field-magnet, made entirely of wrought iron, machined all over. These machines are provided with drum armatures and are ventilated, and we are so satisfied with the success of these machines that we are constructing a series to correspond to the outputs for larger sizes. For constant-current and on high-tension machines we have adopted the double circuit field-magnet, and the sectional ring armature (Joel's patent). The above two types of machine will be our stock pattern. Our patent constant-current machines have found a fair number of buyers. During the past year we have constructed a pair of our D.R. size (37½ units each), and we believe that the great utility of constant-current machines is gradually becoming recognised. Our combined engine and dynamo, consisting of one of our improved high-speed open-type engines, belted to one of our standard-type dynamos by leather link belt and tightened in by a setting-in pulley, and the whole mounted on a box bed-plate of cast iron, has been successfully introduced by us during the past year, and many have been sold and are in successful operation. Our energies have been devoted during the past year to the perfection of machinery for the transmission of power, and for telpherage and light railways. We have constructed 11 electric locomotives for telpher electric railways, some of these having a tractive force of 1,500lb. on the draw-bar. In alternating machinery, we have made considerable improvements. The transformers used for the lighting of Chelmsford by Messrs. Crompton and Co. (Limited) are Statter's patent, and were made by us. Messrs. Crompton have been supplied with some additional ones for their installation at the Barry Docks. We have also taken up the manufacture of alternators for central station lighting, and we have now in hand several for an important central station." This firm has now been incorporated with the United Electrical Engineering Company, under the title of "The Electrical Engineering Corporation (Limited)."

THE ELECTRICAL ACCESSORIES COMPANY (LIMITED).—We have received an illustrated circular from this company showing specimens of the Atkins patent universal shade and globe carrier, ceiling roses, and fancy nurls. Prices are given of all these articles in the circular under notice.

TRADE CALENDAR.—We have received from the Magnolia Anti-Friction Metal Company of Great Britain a handsomely-got-up calendar for 1890, upon which views are shown of the Forth Bridge; the Eiffel Tower; the Statue of Liberty, New York; and the large works of the Company situated close to the Brooklyn Bridge.

———We have also received from Woodhouse and Rawson United (Limited) a useful illustrated calendar, showing a very large number of their well-known manufactures with descriptions attached, and we also have to acknowledge from the same firm a useful celluloid paper knife, giving a calendar for 1890 and French and English measurements.

———From Mr. Samuel Elliott, of Albert Works, Newbury, Berks, we have received a very neat calendar, illustrating many important examples of wood casing, for which Mr. Elliott is well-known throughout the trade. The calendar reflects credit upon the designer.

BOOKS, &c., RECEIVED.

"Rules for Electrical Installations." Compiled and adopted by the Victorian Institute of Engineers and the Fire Underwriters Association of Victoria. (Melbourne: McCarron, Bird, and Co.)

"Medical Electricity and Massage." By H. Newman Lawrence, A.I.E.E. (London: George Gill and Sons.)

PATENT RECORD.

APPLICATIONS FOR PATENTS.

December 27, 1889.

20,797. W. W. STRODE and C. G. GILL. London. Improvements in pendants and other fittings for electric light.

December 28, 1889.

20,856. D. G. FITZGERALD and A. H. HOUGH. London. Improvements in elements for voltaic batteries.

December 30, 1889.

20,885. H. S. PRICE. London. Improvements in and connected with fittings for electric or other lamps.

December 31, 1889.

20,955. J. J. WOOD. London. Improvements in dynamo-electric machines, in part applicable to electro-motors.

20,962. H. H. LAKE. London. Improvements relating to the securing of rings, washers, collars, or other perforated objects to metal bars, rods, or the like by the use of electricity (E. Thompson and H. Lemp, United States).

20,971. O. IMRAY. London. An electric exercising machine (the Electric Exercising Machine Company, United States).

20,975. F. RYSSELBERGHE. London. A system of hydro-electric distribution.

Digitized by Google

January 1, 1890.

29. S. V. Dardier. London. Improvements in the electrical coating of metals on non-metallic substances.
42. W. S. Smith, the younger. London. Improvements in the manufacture of cables suitable for the distribution of electric currents.

January 2, 1890.

57. S. B. Kirschstein and J. Mansergh. London. Shades for oil, gas, electric, candle, or other artificial lamps or lights.
58. H. Gardner. London. An improvement in or connected with incandescent electric lamps (W. Reid, United States).
61. G. Quick. Chipping Campden. Improvements in breach mechanism for ordnance and electric firing arrangements.
81. H. S. Price and H. J. Dowsing. London. Improvements in coin-freed apparatus for supplying currents of electricity and other articles or objects.

January 3, 1890.

113. W. Moseley. London. Improvements in electric meters.

January 4, 1890.

175. R. Mannesmann. London. An improvement in electrical conducting wires and in the manufacture therefor.
180. E. Edwards. London. Improvements in automatic telegraphs (E. Cassalette and D. Kunhardt, Germany.)

January 6, 1890.

232. J. Hopkinson, E. Hopkinson, and G. A. Grindle. London. Improvements in electric motors and dynamo-electric machines.

January 7, 1890.

241. A. Whalley. Warrington. An improvement in telephone switch boards.
249. W. F. King. Glasgow. Improvements in dynamo-electric machines.
261. G. T. Rick and W. R. King. Stratford. Improved electric truss.
272. R. Haddan. London. Improvements in electro-magnetic despatch apparatus (J. T. Williams, United States).
274. A. Natterer. London. Improvements in electric bells.
303. H. H. Lake. London. Improvements relating to secondary batteries (P. H. Alexander, United States).

January 8, 1890.

350. L. Epstein. London. Improvements in the formation of electrodes for use in primary and secondary electric batteries.

January 9, 1890.

402. F. A. Graf. London. Improvements in or connected with electric clocks (D. H. Nahler, Switzerland).
407. H. S. Heath and R. J. Barnes. Leyton. Improvements in electrical automatic machines.
425. J. C. Richardson and H. Moon. London. Improvements in the construction and laying down of high potential electric mains.

January 10, 1890.

475. J. Sack and the Firm Von Maltitz and Ziesel. London. Improvements in or connected with apparatus for telegraphic and telephonic communication.
488. M. Sappey. London. Improvements in and connected with primary batteries.

January 11, 1890.

534. G. Binswanger and H. J. Coates. London. Improvements in electrical switches.

January 13, 1890.

600. J. C. Mewburn. London. Improvements in the manufacture of brushes for dynamo-electric machines (H. Carrière, France).
615. R. B. Evered and T. Rudling. London. Improvements relating to electric circuits for lighting and other purposes, and to devices for controlling the flow of the current therein.

January 14, 1890.

665. P. J. R. Crampton. London. Improvements in or relating to reversible electric motors.
693. S. C. C. Currie. London. Electric motors.
694. J. Clegg. London. Improvements in the manufacture of light-emitters or illuminants for electric and other lamps.
695. J. Clegg. London. Improvements in the manufacture of light-emitters or illuminants for electric and other lamps.
696. J. Clegg. London. Improvements in the manufacture of light-emitters or illuminants for electric and other lamps.

January 15, 1890.

718. A. E. Nichols. Westminster. Improvements in electric lamp couplers or holders.
761. O. Dahl. London. Process of generating electricity by gas batteries. [Date applied for, under Patents Act, 1883, Section 103, June 17, 1889, being date of application in United States.
771. W. Oesterreich and W. Genest. London. Improvements in and connected with telephone systems.

January 16, 1890.

804. W. J. Gardner. Gloucester. An improved form of automatic electric brake for railway and other vehicles.
847. C. Graham and F. Allen. Westminster. Improvements in and relating to electrical communicators for use on travelling vehicles.

January 17, 1890.

872. J. Perry. London. A dynamo machine for alternating currents.
873. J. Perry. London. Improvements in electric supply meters.
878. J. Swinburne. Wimbledon. Improvements in and connected with dynamo machines for producing electric energy, ventilation of culverts for distributing it, accumulators for storing it, and motors for utilising it.
882. G. W. L. Patterson. Newcastle-on-Tyne. Improvements in linesman's testing galvanometers or detectors.
911. S. Pitt. London. Method of and apparatus for winding ribbons or tapes of insulating material around electrical conductors (J. B. Atherton, United States).

SPECIFICATIONS PUBLISHED.

1888.

16,852. Goolden and others. Electric circuits. (Price 8d.)
81,812. Yorke. Distributing electricity. (Price 8d.)

1889.

1,420. King. Secondary batteries. (Price 8d.)
2,003. Shepard. Electric regulating apparatus. (Price 8d.)
2,205. Lancaster. Incandescent electric lamps. (Price 6d.)
2,742. Wagg and Hudson. Switches for suspended "arc" lamps. (Price 6d.)
3,272. Thompson (Westinghouse Electric Company). Electric motors (Price 8d.)
3,330. Hartness. Electric lighting. (Price 6d.)
3,420. Sayers. Dynamo machines. (Price 6d.)
3,674. Abel (Siemens and Halske). Distributing, &c., electric currents (Price 8d.)
5,152. Atkins. Electrical lamp, &c., holders. (Price 8d.)
13,172. Andersen. Underground electrical conductors. (Price 8d.)
14,991. Blathy. Electricity metre. (Price 11d.)
16,241. Carpenter. Secondary batteries. (Price 6d.)
16,709. Lake (Tesla). Converting alternating into direct electric currents. (Price 8d.)
16,710. Goolden and Ravenshaw. Dynamo-electric machines. (Price 6d.)
17,004. Harris. Electric terminals and switches. (Price 6d.)
17,118. Paget and Kintner. Electrical transformers. (Price 8d.)
17,610. Lake (Morgan). Electric signalling. (Price 2s. 4d.)
17,765. Haddan (Williams). Electro-magnetic despatch apparatus. (Price 6d.)
17,781. White. Electric switches. (Price 6d.)
18,010. Timmis. Electric lampholders, &c. (Price 6d.)
18,051. Lake (Morgan). Electric signalling. (Price 1s. 1d.)
18,322. Cumming. Electric coin-freed machines. (Price 6d.)
18,365. Entz and Phillips. Primary and secondary batteries. (Price 6d.)
18,743. Pitt (Dey). Electric conductors. (Price 6d.)
18,817. Birkbeck (Schneider and Zeidler). Operating telephone call bells, &c. (Price 6d.)
18,953. Macaulay-Cruikshank (Johnson and Smith). Secondary batteries. (Price 6d.)
18,966. Enholn. Galvanic batteries. (Price 6d.)
18,989. Smith. Secondary batteries. (Price 6d.)
18,997. Boult (Foeppl). Connecting an accumulator battery in alternating current circuits. (Price 6d.)

Third Edition.—1881.

4,202. Swan. Incandescent electric lamps. (Price 6d.)

COMPANIES' MEETINGS & REPORTS,

The Australasian Electric Light, Power, and Storage Company (Limited).

An extraordinary general meeting of the shareholders of this Company was held yesterday at the offices, 39, Coleman-street, Mr. B. H. Van Tromp presiding.

[The objects for which this meeting was called will be found set out on page 333.]

The SECRETARY (Mr. J. H. Duncan) having read the notice convening the meeting,

The CHAIRMAN said that it would be within the recollection of the shareholders that when they last met he told them of the possibility of there being some little difficulty in getting actual legal possession of the whole of the patents, and that it might be the case that, for the present at all events, there would be a small reduction made in the purchase-money. When he told them that the patents were altogether ninety-seven in number, and that they related to India, Tasmania, New Zealand, Natal, the Cape of Good Hope, Victoria, and all the Australian Colonies, it might be easily imagined that, having regard to the scattered countries to which those patents referred, there had been considerable difficulty in getting, as it were, immediate and actual physical possession of the letters patent and the necessary and proper assignments. The Electrical Engineering Com

Digitized by Google

pany had, he thought, very properly called upon them to show, in the strictest possible way, their full title to those patents, and he was glad to be able to say that they had completed an assignment to that Company of the greater portion of them. They had executed—or would execute in the course of that day—a deed assigning to the Electrical Engineering Company 73 of those patents, representing a value of £23,500 out of the £30,000, which, as they would remember, was the total consideration to be paid for the whole of the patents. It was really £31,000, but that, as they were probably aware, was to include the whole of the expenses of the winding up. That being so, the Board thought it better, in the interests of the Company, rather than wait until they produced proof of their title to the whole of the patents, to go as far as they could, and to complete an agreement with the Brush Company to the extent he had indicated, having regard to the fact that they had the fullest belief that, with respect to nearly the whole of the patents, they would be able, and in a very short time, to show a very good and indefeasible title to them. It was not at present proposed to issue the shares in the Company representing the £23,500, but they would obtain an undertaking from the Brush Company to issue the shares as and when required. It was not proposed that the shares should be issued at once, for the reason he had stated, that he believed they would get nearly the whole of the £30,000, and it that case it would be better to issue the shares at once rather than in driblets. He need not say how difficult it would be in a large body of shareholders to apportion the remaining 3,000 or 4,000 shares, but he hoped that in the course of a month or six weeks they would receive those shares and become proprietors in a new and prosperous undertaking. With regard to the winding up, by the agreement of October last the right was reserved by the Brush Company to purchase the remaining assets at the upset price of £15,000, and they were to exercise that option on or before February 1st. That day was fast approaching, and it had been intimated to that Company that the Board desired them to say whether or not it was their intention to accept the assets undisposed of at £15,000. His own impression was that they would not do so, but that they would prefer the Australasian Company themselves, as a matter of convenience, to realise their own estate. They knew naturally where it was, what it consisted of, and how best to realise it. He might mention the circumstance as showing that the Brush Company desired to bring matters to an issue as soon as possible, that it was at their request that the present meeting had been called, so as to close up the Company and hand over the assets as arranged. And this was the only course open to them. Under the law the Company remained alive, as it were, until such time as they had completely wound up their affairs. With these few observations he would now beg to formally move :

"*That this Company be wound up voluntarily.*"

"*That John Henry Hill Duncan, and Benjamin Humphries Van Tromp be and they are hereby appointed Liquidators of the said Company.*"

"*That the said Liquidators be and they are hereby directed to carry into effect the Agreement entered into between this Company and the Brush Electrical Engineering Company (Limited), dated October 23, 1889, so far as the same remains to be carried out, and either with or without modification.*"

He might add that, though there were very few shareholders at the meeting, in point of fact the Directors had received proxies representing nearly a holding of £60,000, assenting to the object for which the meeting had been convened. He did not think they had received an intimation of dissent from any one shareholder.

Mr. ROWAN seconded the resolutions, which were adopted unanimously and without discussion.

The CHAIRMAN further added that Mr. Sellon, on behalf of the Brush Company, had recently been in Australia, and had come back in the belief that there was a great future for the electric light in that country. About two years ago, having that fact in view, a proposal was made by the Board for increasing the capital of the Company, and circulars were sent out to the shareholders inviting subscriptions, but at that juncture the Directors did not meet with that support which they expected, and they were obliged to make the best terms they possibly could to realise the Company's property.

A vote of thanks to the Chairman terminated the proceedings.

Anglo-American Telegraph Company (Limited).

The following is the report of the Directors of this Company to be presented at the ordinary general half-yearly meeting of the proprietors, to be held at Winchester House, Old Broad-street, London, E.C., on Friday, the 31st inst., at 2 o'clock :—

1. The total receipts from July 1 to December 31, 1889, including the estimated balance of £2,465. 1s. brought forward from the last account, are estimated at £157,109. 4s. 11d. This amount, however, is subject to revision, dependent upon the result of the law-suit still pending between this Company and the Paris and New York Telegraph Company. The traffic receipts show an increase of £23,839, as compared with the corresponding period of last year, and this increase would have been considerably larger had it not been for the interruptions which have occurred during the past year to the cables of the associated companies. For some weeks during the half-year under review the whole of the traffic was thrown on to the cables of this Company, and, in consequence, its volume was sensibly diminished.

2. The total expenses of the half-year, including repair of cables, &c., as shown by the revenue account, amount to £58,611. 12s. 3d.

3. Interim dividends of 12s. 6d. per cent. on the ordinary stock, and 25s. per cent. on the Preferred stock, were paid on November 1st last, absorbing £43,750, leaving an estimated balance of £54,747. 12s. 8d., out of which the Directors recommend the proprietors to declare final dividends of 15s. per cent. on the ordinary stock, and £1. 10s. per cent. on the Preferred stock, amounting to £52,500, making a total distribution for the year ended December 31, 1889, of £2. 15s. per cent. on the ordinary stock, and £5. 10s. per cent. on the Preferred stock, leaving an estimated balance of £2,247. 12s. 8d. to be carried forward to the next account.

4. The Company's repairing s.s. "Minia" has been engaged during the past half-year in the repair of the Brest-St. Pierre cable, broken on July 17th, communication having been restored on September 5, 1889. When at some distance from Falmouth she unfortunately came into collision with an Italian barque, the "Caterina Capurro," of Genoa, during a dense fog. Considerable injury was sustained by both vessels, but as the "Minia" was insured, no direct loss was sustained by the Company beyond the loss of time involved in refitting and the consequent necessity of employing the Telegraph Construction and Maintenance Company's s.s. "Britannia" to repair another fault which appeared in the Brest-St. Pierre cable on November 14th at 150 miles from St. Pierre. The "Britannia," after picking up both ends of the cable, and renewing 35 miles by laying in new cable, was driven by stress of weather and shortness of coal to temporarily abandon the work and return to port. In the meantime the "Minia" had arrived at St. John's, Newfoundland, and, being fully equipped, at once proceeded to the spot, and successfully completed the repair on December 12th.

5. The whole of the Company's system of cables and land lines is now in good working order.

6. The litigation between the Anglo-American Telegraph Company and the Paris and New York Telegraph Company is still pending, the Appeal to the Conseil d'Etat not having yet been heard.

7. The Directors are pleased to be able to report that the Western Union Telegraph Company, lessees of the American Telegraph and Cable Company, have extended their main cables from the landing place at Canso, Nova Scotia, by new cables direct to New York City. This extension will not only greatly expedite the traffic all the year round, to the joint benefit of

PATENT
SILICIUM BRONZE AND SILICIUM COPPER WIRE.
The best for overhead Telephone and Telegraph Lines,
AND ALL ELECTRICAL PURPOSES.
Hard Drawn High Conductivity Copper Wire.
ROLLED AND DRAWN
PHOSPHOR BRONZE.
PHOSPHOR BRONZE
VULCAN PHOSPHOR
DURO METAL
PHOSPHOR BRONZE
BEARINGS, BUSHES,
AND OTHER PARTS OF
ELECTRICAL MACHINERY.
SOLE PROPRIETORS of the British, Indian and Colonial Patents,
THE PHOSPHOR BRONZE COMPANY (Limited),
87, Sumner Street, Southwark, London, S.E.
WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

Digitized by Google

the associated companies, but will neutralise the effect of storms upon the land wires, which during the winter occasionally caused delay in the transmission of messages.

8. As a result of adding to the carrying capacity of the Western Union Company's system by the above extension of their cables, they have been enabled to transfer to this Company the use of two wires between North Sydney and New York City, and, under agreement between the two Companies, this Company will shortly open an office at No. 8, Broad-street, New York, and thus establish direct and complete telegraphic communication between New York and London by their own lines. By the opening of this new office and the extensions referred to, the Company will be placed "in touch" with the New York public, and the Directors hope that the more certain and accelerated service now provided will increase the traffic upon the cables of all the associated companies.

9. In accordance with the Articles of Association, two Directors of the Company, the Right Honourable Viscount Monck and Samuel Barber, Esq., retire at this meeting, and being eligible, offer themselves for re-election. The Directors greatly regret the loss by death of their colleague Sir Daniel Gooch, Bart., who has been connected with the Company from its inception, and assisted in the laying of the original cables. Mr. Charles Burt, till now solicitor to the Company, having retired from professional business, has been elected to fill the vacancy during the remainder of Sir Daniel Gooch's term of office. The Directors consider that Mr. Burt's intimate knowledge of the Company's affairs from the commencement of the undertaking will render his services exceptionally valuable.

10. Mr. Joshua Dean and Mr. Francis Glass, the Auditors, also retire. Mr. Dean offers himself for re-election, but Mr. Glass, on account of failing health, does not desire re-election, so that the appointment of a new Auditor will be necessary

NEW COMPANIES REGISTERED.

THE BANGWAKETSI CONCESSIONS SYNDICATE (LIMITED).—Registered by R. Jordan, 120, Chancery-lane, E.C., with a capital of £30,000, in £1 shares, with power to increase or reduce the same, and to issue any of the shares of the syndicate for the time being, either at par or at a premium. Object: to adopt and make binding upon the syndicate, and to carry into effect an existing proprietorship between Ferrar Fenton of the first part, Reginald Fenton of the second part, James Potter Ablett of the third part, and Charles James Riley of the fourth part; to carry on and develop certain concessions or leases for 99 years, for the selection of trading stations, and for the construction of railways, telegraphs and telephones, and for the production and selling electric light, and the erection of factories and other industrial works upon the said properties, and dealing in the products thereof, granted by the paramount Chief Bathoen in the Bangwaketsi country, and to obtain other concessions as well as leases, leases and lands for trading, and all other commercial purposes, in the neighbouring territories; to carry on the business of a mining, smelting, trading, and metallurgical syndicate, in all its branches, in South Africa, Great Britain, and elsewhere. The number of directors shall not be less than three nor more than nine, and the first shall be appointed by a majority of the subscribers to the memorandum of association. The directors' remuneration shall be at the rate of £100 per annum, with an additional £10 per annum to the chairman.

MILLS CYCLE COMPANY (LIMITED).—This Company was registered on the 18th inst. with a capital of £10,000, in £5 shares, to carry on the business of cycle manufacturers, and to carry out an unregistered agreement of 8th inst. between George Pilkington Mills and Nathaniel Hemming; also to trade as electricians, iron and brass founders, and engineers. Solicitors: Messrs. Burgess and Cosens, 9, Finsbury-circus.

NORWICH ELECTRICITY SUPPLY COMPANY.—Objects: To carry on at Norwich and elsewhere the business of an electricity company in all its branches. Capital, £50,000 in £10 shares. Borrowing powers not to exceed nominal amount of capital. Registered January 25th by George B. Kennett, solicitor, Norwich.

A NEW COMPANY.—The formation of a limited company, with a capital of 30,000,000 marks, for the construction of hydraulic and electric power distribution works in German towns (Popps' patent), is announced from Berlin.

CITY NOTES, &c.

AUSTRALASIAN ELECTRIC LIGHT, POWER, AND STORAGE COMPANY (LIMITED).—The following circular has been issued to the shareholders of this Company:—"I beg to give you notice that an extraordinary general meeting of the shareholders of the above Company will be held at the registered offices of the Company, situate at 39, Coleman-street, in the City of London, on Thursday, January 30th next, at 12 o'clock noon, at which it will be proposed to pass the following resolutions, viz.:—1. That this Company be wound up voluntarily. 2. That John Henry Hill Duncan, and Benjamin Humphries Van Tromp be, and they are hereby appointed liquidators of the said Company. 3. That the said liquidators be and they are hereby directed to carry into effect the agreement entered into between this Company and the Brush Electrical Engineering Company, Limited, dated October 23, 1889, so far as the same remains to be carried out, and either with or without modification.—By order of the Board, J. H. Duncan, F.C.A., Secretary." The circular further states that the assignment of the patents and other assets disposed of to the Brush Electrical Engineering Company (Limited) is practically completed, and it is expected that it will be absolutely so before the date of the meeting hereby called, at which the Directors will no doubt be able to give final information as to the state of matters. A report of the Proceedings at the above meeting will be found on page 331.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended January 24th amounted to £5,354.

CONTINENTAL INDIA RUBBER WORKS.—The Continental India Rubber Works in Hanover has announced a dividend of 2fr. per cent. for 1889.

EDISON-SWAN UNITED ELECTRIC LIGHT COMPANY.—This Company intend to pay an *ad interim* dividend at the rate of 7 per cent. per annum upon the "A" shares, to be distributed in accordance with the Articles of Association. It is intended to issue the dividend warrants on February 20th.

MORGAN'S AUTOMATIC ELECTRIC SIGNAL SYSTEM SYNDICATE.—Objects: To acquire, develop, and turn to account rights of any description connected with Morgan's Automatic Electric Signal System, and to carry on any manufacturing business likely to effectuate such objects, adopting therefor an agreement dated January 24, 1890, made with Otto Friederici, the particulars of which are not specified in the Articles of Association. Capital, £5,000, in £100 shares. Registered, January 27th, by Hindson, Miller, and Vernon, solicitors, 8 and 10, Moorgate-street.

SCHANSCHIEFF ELECTRIC SYNDICATE.—On Wednesday last week a meeting of the shareholders of the Schanschieff Electric Battery Syndicate (Limited) was held at the offices of the Company, 44, Basinghall-street. Representatives of the press were not admitted.

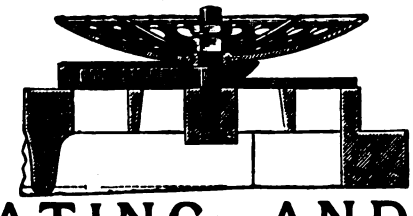
THE AMERICAN BELL TELEPHONE COMPANY.—A correspondent writes:—"Net earnings in 1889 applicable to dividends were not far short of $2,700,000, as against $2,436,464 in 1888, $2,237,608 in 1887, $1,973,351 in 1886, and $1,809,996 in 1885. This shows an average rate of increase from year to year for the last three years of 10½ per cent. Bell's dividends are $18 per annum, and the stock now sells at 200, showing 9 per cent. on the investment. The Bell's patent will expire by limitation shortly, but the Company has possession of the field, and is apparently established on a sound basis."

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended January 24th, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £4,044.

WINFIELDS (LIMITED).—A petition for the reduction of the capital of this Company came before Mr. Justice North in the Chancery Division on Saturday last. It was proposed to reduce the capital, now standing at £160,000 (divided into 24,000 Preference shares of £5 each, and 8,000 ordinary shares of £5), by the sum of £49,634; and, further, to reduce the nominal amount of the unissued Preference shares from £5 to £3 a share. It was stated that no dividend had been paid since November, 1887, and that each year the losses had been carried to a profit and loss account, the accumulated deficit amounting to £7,859. The stock, plant, electric installation and machinery had become depreciated, amongst other causes, from the fall in the price of copper. His lordship granted the petition.

NEW VALVE

No Rubber, Percha, or Leather.



One-half the price of Rubber or Metal.

FOR CIRCULATING AND AIR PUMPS.

Unaffected by any Lubricating Oils. Does not Expand in diameter. Feed Water may be worked at any temperature Suitable for any shaped guards. Only one quality manufactured.

"12, John-street, Sunderland, 28th Sept. 1885.

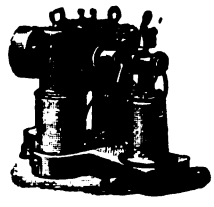
"DEAR SIRS,—In reply to your letter of the 25th inst., the Valves I got from you have done their work well, and ARE AN UNQUALIFIED SUCCESS. I will continue to get them from you as required.—Yours faithfully, JAMES WESTOLL."

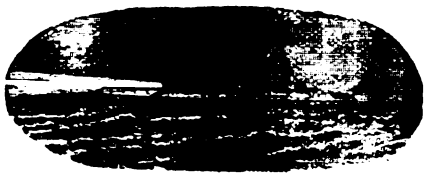
For further Testimony and Prices, apply to MOSSES & MITCHELL, 68-71, Chiswell Street, London.

Digitized by Google

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Wednesday, Jan. 29, 1890	Rate per Cent. Yielded.	Dividend Due.	Business Done during Week Ending Jan. 29, 1890.	
£			**TELEGRAPHS.**		£ s. d.		Highest.	Lowest.
1,770,360	Stock	12/6	Anglo-American	50½ 51½	5 6 10	Jan., Apr., July, Oct.	51⅝	..
2,614,820	Stock	25/0	Do. Preferred	86 87	6 6 5	,, ,,	87⅛	86
2,614,820	Stock	...	Do. Deferred	15½ 15⅝	...	February	15⅞	15⅜
130,000	£10	3/0	Brazilian Submarine	12 12½	6 0 0	Mar., June, Oct., Dec.	12 15/16	12¼
112,900	£100	5%	Do. 5 per Cent. Bonds	102 104	4 16 2	January and July	...	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	104 107	4 13 6	June and December.	...	...
16,000	10	9/0	Cuba Submarine	14½ 15	6 0 0	February and August	14½	...
6,000	10	10%	Do. Preference 10%	19½ 20½	4 19 9	,, ,,	...	...
12,931	5	2/0	Direct Spanish (£4 paid)	4 4½	4 8 11	March & September	...	...
6,000	5	10%	Do. Preference 10%	9 10	5 0 0	April and October	...	...
60,710	20	3/6	Direct United States	10 10¼	6 16 7	Jan., Apr., July, Oct.	10¼	10
380,000	10	2/6	Eastern	13⅜ 14¼	4 11 3	,, ,,	14⅜	13 15/16
70,000	10	6%	Do. 6 per Cent. Preference	15 15⅜	3 17 5	,, ,,	14⅞	...
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock	105 107	3 14 9	May and November.	106½	105⅞
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	108 111	4 10 1	February & August	109½	...
250,000	10	2/6	Eastern Extension	13⅜ 14	4 12 10	Jan., Apr., July, Oct.	14	13⅜
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	102 104	3 16 1	February & August	...	...
473,000	100	5%	Do. 5 per Ct. (Austrln. Gov. Sub.) Debs. 1900	102 105	4 15 3	January and July	103½	...
179,177	10	2/0	Globe Telegraph and Trust	8⅜ 9	5 13 7	Jan., Apr., July, Oct.	8 1/16	8 1/16
178,992	10	6%	Do. 6 per Cent. Preference	14⅛ 14⅜	4 1 4	,, ,,	14⅜	14⅛
150,000	10	5/0	Great Northern	15⅛ 15⅜	4 15 3	Jan., July, and April	15 1/16	15⅛
17,000	25	12/6	Indo-European	41 43	5 16 3	April and October	...	...
9,000	8	4/0	Reuter's	7 7⅛	5 6 5	April and October	...	...
15,609	10	3/6	West African Telegraph	9½ 10⅛	...	...	...	...
300,000	100	5%	Do. 5 per Cent. Debentures	99 102	4 18 0	March & September	101½	100⅛
30,000	10	5/0	West Coast of America	10⅜ 11¼	4 8 11	January and July	11 1/16	10⅜
150,000	100	8%	Do. Debentures 8%	119 124	6 9 1	June and December	...	...
88,321	10	nil.	West India and Panama	2¼ 3⅛	...	...	3	2 1/16
24,563	10	12/0	Do. 1st Preference 6%	11⅜ 12¼	...	April and October	12	...
4,669	10	10/0	Do. 6 per Cent. 2nd Preference	14½ 15⅝	3 17 5	...	15⅛	...
45,181	15	6/0	Western Brazilian	9¼ 9⅝	7 13 10	May & November	9¼	9½
$1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	118 122	5 14 9	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	101 103	5 16 6	March & September	102	...
			TELEPHONES.					
224,850	14/0	5%	Consolidated Telephone and Maintenance	0 1/16 1⅛	...	Yearly	...	...
220,000	£1	3%	Oriental (11s. paid)	1/16 1/16	3 15 11	...	...	...
80,000	5	6%	National	5⅛ 5⅜	...	June and December.	5⅜	5⅛
55,000	5	3/0	United River Plate	4⅜ 5¼	...	January and July	4 1/16	...
			ELECTRIC LIGHT.					
500,000	10	...	Metropolitan Electric Supply (£5 paid)	4½ 5	...	...	4 1/16	...
79,934	5	6%	Swan United (£3. 10s. paid)	5 5⅛	3 16 5	...	5⅛	5 1/16
			MISCELLANEOUS.					
37,350	12	12/0	Telegraph Construction and Maintenance	45 47	5 2 3	March and July	46½	45½
41,600	10	10/0	India Rubber, Gutta Percha & Telegraph Works	18 19	5 5 3	February & August	18⅛	17⅝





Before Ordering!

ELECTRICAL PLANT & ACCESSORIES

WRITE FOR THE FOLLOWING PAMPHLETS TO THE

UNITED ELECTRICAL ENGINEERING CO., Ltd.

Head Offices: 3, Princes Mansions, VICTORIA ST., WESTMINSTER.

"ELECTRICAL DISTRIBUTION."—Commercially considered, with Estimates.

"MACHINE DRIVING BY ELECTRICITY."—The Uses of Electro-Motors for Traction and Stationary Purposes.

"THE TELPHER SYSTEM OF CHEAP TRANSPORT," for Minerals, Goods and Passengers.

"ELECTRICAL SUPPLIES."—Prices and Particulars of the most approved Electrical Appliances

ELECTRICAL PLANT ON VIEW.

Digitized by Google

THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 612.—Vol. XXIV. FRIDAY, FEBRUARY 7, 1890. Price Fourpence.

NOTES.

Some not unnatural surprise has been expressed in various quarters that the Electrical Trades Committee of the London Chamber of Commerce took no action at its meeting last week in respect to the "blocking orders" which are being pressed forward by local authorities owning gas works, with the object of excluding electric lighting undertakers from outside. The matter was, however, privately discussed prior to the meeting, and there being a general consensus of opinion that for the present, at any rate, it would be sufficient to keep a sharp watch on the local authorities in question, the subject was allowed to drop. The large amount of work now in hand and in prospect, no doubt greatly contributed to the adoption of this attitude of masterly inactivity. We would, however, point out that the danger to be apprehended is not so much that gas-owning local authorities will take no steps whatever to exercise their statutory powers, but that they will pursue the far more insidious policy of doing the work in a perfunctory manner. Such tactics, if skilfully worked, would enable them to say to the Board of Trade, on the one hand, "We are, you see, fulfilling our obligations, but there is really no demand for the light;" and to the ratepayers, on the other hand, "We would willingly extend our operations, but electric lighting does not pay"—a mode of obstruction which would probably prove highly effective.

We may mention in this connection that in consequence of the overworked state of the staff, it is said to be the intention of the Board of Trade to proceed only with unopposed Orders this Session.

In view of the present rapid increase in house lighting, and the consequent need for satisfactory meters, the report of Mr. Kapp on the performance of the Aron meter is most opportune. A reason often advanced by parish authorities against the adoption of the electric light is the assumed absence of any commercially reliable meter. It will be seen from the report in our columns that this objection is quite groundless. The Aron meter has been tested for both direct and alternating currents, varying in value from the largest to the smallest intended to be used with it. Mr. Kapp finds that if the meter is properly adjusted when it is installed, the maximum possible error is one-half per cent. with direct currents, and one and a-quarter per cent. with alternate currents. In practice the error would be much less. The Aron meter seems, therefore, more correct than a gas meter, and its accuracy more than sufficient for practical purposes.

Prof. Fitzgerald and F. T. Trouton, in letters communicated to our contemporary *Nature*, have referred to experiments showing that multiple resonance has already been observed in connection with electric oscillations. It seems that some of Hertz's earlier experiments were more especially concerned with these very effects. It has been found by Trouton that the distance between the nodes alters when a change is made in the dimensions either of the resonator or of the vibrator. In the experiments of Sarasin and Rive, which we published last week, the wave length was found to be altered only when the resonator was changed. If the resonator is such that it will, when acting as a radiator, give out waves of several periods, it will, when acting as a resonator, respond to any wave whose period is one of these. It is desirable to obtain a resonator responding only to waves of one period, and in this Sarasin and Rive appear to have succeeded, since only one wave length was noticed with each resonator. Trouton points out that Hertz has always chosen his receiver so as to give the longest spark, and has thus ensured resonance with the most prominent waves of the oscillator, the frequency of these being presumably given by the ordinary theory.

From the same source we learn that if a high-resistance galvanometer be connected with two sides of the resonator a deflection is obtained whenever a spark passes. This method of detection is not only much more sensitive than the optical one, but has the great advantage that the observing instruments can be placed at a great distance from the receiver. Prof. Fitzgerald states that the method has yielded satisfactory results when the wave length of the oscillations investigated has been only 0·6 metre.

We publish this week a full abstract of the paper on "Galvanometers" by Messrs. Ayrton, Mather, and Sumpner, which was read at the Physical Society on January 17th. The Paper covers a great deal of ground and represents the results of an immense amount of careful and patient work. The very full investigation of the different factors which together determine the sensitiveness of a galvanometer should be of great value to makers of these instruments. Some of the improvements

Digitized by Google

suggested are of an extremely fundamental character, and we would remind our readers that the Paper is to be discussed at the meeting of the Physical Society this afternoon, and urge such of them as are interested in the manufacture of galvanometers, and who may have suggestions to make or criticisms to offer, to attend the meeting and take part in the discussion. The fact that galvanometers of the d'Arsonval type may be constructed to give deflections proportional to the current strength over a considerable range is of great importance, especially in view of the conclusion arrived at by the authors, that a modification of the d'Arsonval type of galvanometer is the one from which the highest degree of sensitiveness is to be expected. Instrument makers would do well to lay to heart the remarks on the insulation of galvanometer coils and terminals.

SOME of the earlier of the many valuable researches of Dr. GORE were concerned with the molecular changes occurring when iron is heated or cooled. These investigations, as Dr. GORE points out in our columns this week, have formed the basis of subsequent experiments. They were probably not alluded to in Dr. HOPKINSON'S address because the aim of the President was to summarise the most important facts about magnetism, and to emphasise certain of them, rather than to judge the work of the various experimenters to whom these facts are due.

M. ALPHONSE BERGET has recently communicated to the *Comptes Rendus* the results of some experiments to determine the relative conductivities of various metals for heat and electricity. The thermal conductivity was found by comparison with that of mercury which had been previously measured. The electric conductivity was determined by means of Sir WILLIAM THOMSON'S double bridge. The same specimens of metal were used for the two measurements, which were all made at temperatures varying from 0° to 30°. It was found that the numbers representing the ratio of the electric and thermal conductivities of the metals copper, zinc, brass, iron, tin, lead, antimony, and mercury are respectively 1·6, 1·7, 1·7, 1·7, 1·8, 1·6, 1·7, and 1·8. The two conductivities may, therefore, for most purposes be regarded as proportional, although the ratio is not rigorously constant. Experiments were also made to determine the influence of temperature on the conducting powers of the metal mercury. It was found that between 0° and 300° C. the percentage decrease of conductivity per degree is 0·046 for the thermal, and 0·085 for the electric conductivity.

THE formula of M. GÉRARD for calculating the candle-power of arc lamps fed with continuous currents seems sufficiently accurate for practical purposes. This formula states that the mean spherical luminous intensity is equal to half the horizontal intensity, together with one-quarter of the maximum intensity. According to the *Centralblatt für Electrotechnik*, experiments on several different lamps have shown that M. GÉRARD'S formula gives the candle-power within about 5 per cent.

PROF. LANGLEY has recently been investigating, by means of his bolometer, the comparative radiation of the sun and the electric arc in different parts of the spectrum. The result given is that the solar radiation in the orange and red is nearly ten times that of the arc. Towards the violet end of the spectrum the relative importance of the sun's rays is less, owing to atmospheric absorption. The solar rays are relatively stronger than those of the arc in all parts of the infra red spectrum known until lately, although in the extreme portions recently investigated the rays of the arc are more powerful. When allowance is made for atmospheric absorption it is found that the superiority of the sun's rays over those of the arc continuously increases in proceeding from the ultra red to the ultra violet portions of the spectrum, the number expressing the ratio being 4 in the extreme red, 10 in the orange and red, and 26 in the extreme violet. These results show that there is considerable atmospheric absorption in the extreme parts of the spectrum, although in the red portions very little occurs.

THE 1890 edition of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK is now ready. No pains have been spared to make the Directory both accurate and complete, and the Handbook Section will be found to contain several valuable additions. Amongst the new features of the Handbook are a full Digest of the Law relating to Electric Lighting, which has been specially prepared for this work by Mr. A. C. CURTIS HAYWARD, and the Tables of Limiting Currents for Electric Light Conductors, recently drawn up by Mr. A. E. KENNELLY. The growth of this publication has been contemporaneous with that of the electrical industry. In 1883 the Directory consisted of 72 pages; the 1890 edition contains 850 pages. In 1883 it was found possible to include the various branches of the industry under less than 60 headings; in 1890 400 headings scarcely suffice.

Exhibition at Liege.—A National and International Exhibition is to be opened at Liège in June next.

Restoration of Telegraphic Communication.—Telegraphic communication with the Isle of Skye has been restored.

Berlin.—The Niederschlesisch Märkischen Bahn Station at Berlin is to be lighted by electricity at an estimated cost of 103,000 marks.

Telephonic Development.—The first message from Birmingham to St. Helens on the new extension wires of the National Telephone Company was transmitted on Friday last *vid* Manchester.

London Chamber of Commerce.—Among the companies elected members of the London Chamber of Commerce, at the January Council meeting, was the Metropolitan Electric Supply Company.

A Costly Telegram.—The Italian papers state that the telegram sent to Rio de Janeiro by the King of Italy to the son of the Duke d'Aosta, announcing the Duke's decease, contained 1,200 words, and cost £534 1s. 3½d.

Dr. Werner von Siemens.—Dr. Werner von Siemens, who has just retired from business, is engaged in writing his autobiography, which will, it is stated, contain some interesting details of the development of the Siemens and Halske business.

Cheltenham.—At the last meeting of the Town Council a communication was read from Messrs. Laing, Wharton, and Down, intimating that they had withdrawn their application

Digitized by Google

for a Provisional Order, in deference to the application of the Corporation.

The Lighting of the City.—At the last meeting of the Commissioners of Sewers, a letter from the Brush Electrical Engineering Company asking that the western division of the City might be included in their electric lighting contract as well as the central, was referred to a committee.

Royal Institution.—As will be seen by our advertisement columns, Lord Rayleigh will begin a course of seven lectures on "Electricity and Magnetism" on Saturday, February 15th. As these lectures are on Saturdays, in the afternoon, it is anticipated that they will be very largely attended by students and others.

Wrexham.—At the last meeting of the Town Council there was a lengthy discussion on the draft Provisional Order applied for by the Wrexham and District Electric Supply Company. It was finally decided to confirm the minutes of the Lighting Committee, and to lodge the necessary objections to the Order.

Camberwell Vestry.—At the last meeting of this Vestry the report of the General Purposes Committee on the subject of the electric lighting Orders was adopted by 25 to 22, consent being given to the Orders of the London Electric Supply Corporation and the Electric Construction and Maintenance Company.

The Halifax-Bermudas Cable.—It is announced that the English Government have prolonged the time originally allowed for the laying of this cable to the 24th June. The company intend, it is also stated, to complete the scheme by telegraphically connecting the Bermudas with the Bahama Islands and Jamaica.

Bath.—At the last meeting of the Town Council the Special Electric Lighting Committee presented their report on the work by Mr. Massingham, in pursuance of the contracts between him and the local authority. In moving the adoption of the report, Mr. Sturges expressed the opinion that the Company had worked very well and met them fairly.

Breslau.—The Town Council of Breslau has accepted a tender for the supply of electric lighting plant, sufficient to run 7,500 to 8,000 16 candle-power lamps simultaneously. Accumulators capable of supplying 400 lamps for five hours will also be provided to meet the demand for the light during the day. The cost, according to Messrs. Siemens and Halske's tender, will be 910,000 marks.

Telephonic Communication between Berlin and Vienna.—The proposed telephone trunk wire between Berlin and Vienna, a distance of about 400 miles, is receiving much attention. The preliminary experiments have been made, and with such success that negotiations have been commenced between the two Governments with a view to an agreement for the immediate construction of the line.

Tunis.—The Société Générale des Téléphones is about to undertake the construction of a telephone system in Tunis. The subscription to the exchange is to be 200fr. per annum, the subscriber having to pay, in addition to the annual rental, a first charge of 150fr. per mile of wire between his house and the exchange, and 75fr. for the apparatus installed. A two years' subscription must also be guaranteed.

College Lighting.—An installation comprising eighty 16 candle-power incandescents has just been fitted up in the School of Anatomy, Trinity College, Dublin, by the firm of J. Edmundson and Co., of Capel-street. The motive power is supplied by a 7 horse-power nominal Otto gas engine, which actuates a 5-unit Elwell-Parker dynamo. In addition there is a storage battery capable of supplying fifty 16-candle lamps for ten hours.

London Tramways Company.—An extraordinary general meeting of the shareholders of this company was held on Tuesday to confirm the special resolution passed at the general meeting of the shareholders held in January, approving a Bill deposited by the company in Parliament, entituled "London Tramways Company (Limited) Bill, 1890." The object of the Bill is to allow of the company making use of electric or any other power which may be discovered in the drawing or driving of their road cars. The resolution was formally approved.

Chelmsford.—At the meeting of the Town Council last week, it was announced that the Board of Trade report on the subject of the electric light wires and posts had been received, but that being a lengthy document it had not yet been perused by the Lighting Committee. The Mayor, in reply to a question, said that he had been informed that the electric light might be ready in a fortnight.—According to the *Essex Telegraph*, much of the wire which has been put up at Chelmsford will have to be taken down, and other wire substituted for it. Messrs. Crompton and Co. are not satisfied with the quality of the wire in question, its conductivity being, they allege, very low.

The Relation between Magnetic Properties and Atomic Weights.—Success has not hitherto attended attempts to apply the periodic law to the classification of elementary bodies according to their magnetic properties. M. Bachmetieff, however, claims to have succeeded somewhat better than others. He has constructed a curve, the abscissæ of which are the atomic weights, and the ordinates the magnetic values of the elements—paramagnetic values being measured above the line, and diamagnetic values below it. The result is an irregular but continuous sinusoid. The curve is, of course, quite arbitrary in several parts, since the necessary data are not yet forthcoming.

The Telegraph in Persia.—The Director-General of Indian Telegraphs, in his yearly report, states that in February last an application was received from the Persian Government for material for the construction of a line of telegraph from Burujird to Muhammera, the object being to facilitate the opening up of the Karun River as an international trade route. The stores asked for were supplied in May last. During the year reported on a telegraph line, 60 miles long, from Ispahan to Kalleh Kazir, was constructed by the officials of the Indo-European Telegraph Department, at the request of His Royal Highness the Zil-es-Sultan, who has expressed his gratitude for the service in the warmest terms.

Liverpool.—At the last meeting of the shareholders of the Liverpool Tram and Omnibus Company, the chairman, Sir David Radcliffe, referred to the electric cars which were about to be tried in Liverpool, and said the delay in trial was on account of the steep gradients, which necessitated the designing of special cars and apparatus. A letter was read from Lord Bury explaining these points, and stating that the experience gained by his company on the North Metropolitan Tramway at Barking compelled them to design motors of greater power than they had at first anticipated, that the experimental car was nearly completed, and that all the difficulties, as far as they could see, had been overcome.

Lambeth Vestry.—At the last meeting of this Vestry the Electric Lighting Committee reported that draft orders had been lodged with the Board of Trade by the London Electric Supply Corporation, Metropolitan Electric Supply Company, House-to-House Electric Light Supply Company, and the Electric Construction and Maintenance Company. Having considered the whole of the orders, they recommended that assent should be given to the House-to-House Company and the Electric Construction Company, and that objections should be lodged against the Orders asked for by the London and Metropolitan Companies. An amendment was, however, carried to the effect that objections should be lodged against all four companies.

St. James's Vestry.—At the last meeting of this Vestry the Lighting Committee reported that the mains being laid in the streets by the London Electric Supply Corporation were at less depth than 6in. below the surface of the pavement, and they regarded the same as a source of great danger. They had caused notice to be served upon the company requiring them to take up the whole length of main already laid by them under the streets of the parish, differing from the specimen main submitted and assented to by the Vestry, and to discontinue laying mains in this parish, except as assented to by the Vestry. They had authorised the vestry clerk to take further action, if necessary, to restrain them by an injunction. The report was adopted *nem. con.*

Salzburg.—The Salzburg central station is interesting from the fact that the dynamos are intended to be run by day for a

Digitized by Google

mountain railway. The station is established near the Salzbach, which runs through the town. The plant comprises two steam-engines of 30 and 60 horse-power, which drive three Siemens and Halske shunt-wound dynamos, of 140 volts and 125 amperes, at 940 revolutions. The cables are concentric and armoured. At the present moment the station only supplies some 500 lamps, but its plant capacity is equivalent to 1,200 lamps. It is proposed to run an electric railway to the summit of the Monschberg. Some 18 horse-power will be required for this work, and a single dynamo at the station will therefore suffice to supply the necessary current.

The Destruction of the Edison Station in Pearl-street.—In a letter to a M. Vernes, published in the last number of the *Bulletin International de l'Electricité*, Mr. Edison writes as follows:—"I thank you for your letter of the 10th instant. The fire at the Pearl-street station took place on Thursday, and completely destroyed it. On Saturday our men set to work, and by the following Saturday current was again being supplied from Pearl-street to the 20,000 lamps fed by the old station. This *tour de force* was accomplished in six days of 24 hours. Would you be capable of such a feat in Paris? The losses will not be great, since the damage done by the fire is covered by insurance, and the cost of operating the new station will be 30 per cent. less than that of operating the old."

Central London Railway Scheme.—At the last meeting of the City of London Tradesmen's Club an amendment was carried that the club should not give unqualified support to the Central London Railway until the City and Southwark Subway has proved the great success foreshadowed by Mr. Greathead.—At the last meeting of the City Commission of Sewers a petition was presented from owners of land and property and lessees and occupiers of houses in Holborn, Holborn-viaduct, Newgate-street, Cheapside, Poultry, King William-street, and Arthur-street, against the Central London Railway scheme, on the ground of the injury it would occasion them, and the enormous inconvenience which would result to the public. The petition was referred to the Finance and Improvement Committee.

Bridlington.—The action taken by the local board at its last meeting opens up the possibility of the town being without the means of public lighting after the 25th proximo. Tenders had been advertised for the lighting of the district either by gas or electricity. Two tenders had been received—one from the gas company, offering to light by gas at 35s. 6d. per lamp for 1,200 hours, and the other from an electric lighting company on the Thomson-Houston system, who would put down 28 arc lamps and 160 Edison-Swan incandescent lights for £900 a year on a contract for five years. The motion in favour of accepting the gas company's tender was lost by one vote, while that in favour of the electric lighting scheme was lost by two votes. Both tenders were thus rejected, and if some arrangement be not entered into before the expiration of the present contract for gas the town will be left in darkness.

The Edison General Electric Light Company.—At the first annual meeting of the Edison General Electric Light Company the report of the company, says the *Iron Age* of New York, showed the great expansion of the business of electric lighting during 1889, and indicated that there would be even greater growth in 1890. One item in the report says: "The new business in sight in every department is in such a state that, if the company succeed in increasing their capacity sufficiently to execute it, the gross receipts in 1890 will be twice as large as in 1887-1888." The number of *employés* in the Schenectady shops in 1888 were 750, last year 1,300, and this year it is proposed to increase the working force to 2,000. A large number of men are also employed in other places and in the other departments of the company's works. During the past year 2,500 dynamos and motors were manufactured. The number of street-railway cars equipped with motors was 551.

The Electrolytic Preparation of Sodium and Aluminium.—In the course of his researches on the electrolytic preparation of aluminium M. Roger has been led to mix the salt of aluminium with an alloy of lead and sodium, a method which he claims greatly increases the yield of aluminium. The lead-sodium alloy is obtained by the electrolysis of a solution of sea salt, a lead plate being employed as cathode. In one of the first experiments a current of 80 amperes at 24 volts traversed four crucibles arranged in series, each of which contained the following mixture:—One part of cryolite, three parts of sea salt, and 27 grammes of lead. After six hours 15 grammes of aluminium were recovered, and there remained at the bottom of the crucibles a quantity of fused sodium and cryolite. According to M. Roger this process will enable 500 grammes of aluminium to be obtained by the expenditure of 1 horse-power for 24 hours, or 80 per cent. of the theoretical maximum yield.

The Pont-de-Vaux Central Station.—Pont-de-Vaux (Ain), the population of which is only 3,500 persons, is probably the smallest town in the world possessing a central lighting station. The system adopted is the modified Edison three-wire system, with feeders, and the plant consists of two steam engines, each of 40 horse-power, driving by belting two Bovy dynamos, having an output of 200 amperes and 137 volts. For the public lighting only fifty 16 candle-power lamps have as yet been put up. The station is situated from the most distant lamp only half-a-mile. To avoid the use of two dynamos a compensating device to re-establish the equilibrium between the two circuits, as first suggested by Prof. Elihu Thomson, has been employed, and each of the two circuits is fed by a dynamo connected to a compensating system, consisting of two small dynamos run in parallel. Khotinsky lamps are employed, and current is charged for at the rate of £2 per 16 candle-power lamp per annum.

Telegraph Wires across the Forth Bridge.—The telegraph department of the North British Railway are at present engaged in laying telegraph wires across the Forth Bridge. Up till now telegraphic communication between the north and south of Scotland has been maintained by means of cables under the Forth, a system which has proved very expensive owing to the damage frequently caused to the cables by ships dragging their anchors. The erection of the bridge, however, does away with necessity for submarine wires, and when the communication by the viaduct has been properly established, it is proposed to remove most of the cables in the Firth. Altogether fifty wires are being laid across the bridge, enclosed in two 2-inch iron tubes—twenty for the use of the Railway Company, and thirty for the use of the General Post Office. Three cables will be lifted at Queensferry, and four at Burntisland, but the cable from Granton to Aberdour will be allowed to remain.

Islington Vestry.—At the last meeting of this Vestry the Special Committee appointed by the Vestry to inquire into the subject of electric lighting reported that neither the order of the Brush Electrical Engineering Company nor that of the House-to-House Electric Light Supply Company made provision for generating stations, and only provided for the deposit of £1,000 each in respect to the areas affected by the Orders. The Committee was of opinion that the two companies should be required to deposit at least £1,000 each in respect of their works in the parish of Islington alone. The Committee further recommended that all reference to the County Council in connection with the control of overhead wires and the breaking-up of streets in the parish be omitted, and that the Brush Company be required to omit the clause enabling it, with the sanction of the Board of Trade, to transfer its Order. The report was adopted, and the Committee was empowered to serve the requisite notices of objection.

The Requisites of a Mining Motor.—In a short article on "The Conditions of Efficiency in Electrical Mining Machinery," in the *Electrical World* of January 4th, Dr. Louis Bell sums up the requisites of a good mining motor in the following terms:—"The distribution of power from a central station to all the portions of a distant mine by any of the methods in use up to the present involves so serious a loss that electricity need fear no severe competition on the ground of efficiency. Consequently, the point to be aimed at in building electrical mining machinery is to make a strong, well-insulated motor, easy to manage and to repair, and which will do the work required. If the armatures and fields can be made thoroughly waterproof and able to withstand a reasonable amount of heating, the question of electrical efficiency may be put aside for the present. When a motor has been built that will do this rough mining

Digitized by Google

work, and do it without the necessity of frequent attention or repairs, it will be time enough to look for a theoretical efficiency."

Indo-European Telegraph Department.—The receipts of the Indo-European Telegraph Department for 1889 amounted to 11,44,600 rupees, as against 10,35,235 rupees in 1887-88, the increase being mainly due to the fact that there was more traffic in consequence of breaks in the Eastern Company's cables in August and September, 1888. The working expenses of the year were 9,53,223 rupees, and the net revenue 1,91,377 rupees, the increase of expenditure being mainly due to the cost of extensive repairs and renewals that have been carried out. It has been decided to lift and thoroughly rehabilitate the 1864 cables throughout, at a cost of 7,03,000 rupees, to be distributed over three or four years. During this year, 201 knots of cable were expended in renewals and repairs. It is satisfactory to find that throughout the year there was no break on the Persian Gulf Section between Kurrachee and Bushire which affected communication between the East and Europe. On the Persian Section the interruptions, owing to the severity of the winter, were rather in excess of those of the year 1887-88, and the period of total interruption, mainly due to a great snowstorm at Shiraz, amounted to 50 hours 24 minutes.

Electric Currents in the Skin.—An interesting study has been lately made by Herr Tarchenoff of electric currents in the skin from mental excitation. Unpolarisable clay electrodes, connected with a delicate galvanometer, were applied to various parts—hands, fingers, feet, toes, nose, ear, and back; and, after compensation of any currents which occurred during rest, the effects of mental stimulation were noted. Light tickling with a brush causes, after a few seconds' period of latency, a gradually increasing strong deflec ion. Hot water has a like effect; cold, or the pain from a needle-prick, a less. Sound, light, taste, and smell stimuli act similarly. If the eyes have been closed some time, mere opening of them causes a considerable deflection from the skin of the hand. It is remarkable that these skin-currents also arise when the sensations are merely imagined. Mental effort produces currents varying with its amount. If a person is in tense expectation, the galvanometer mirror makes irregular oscillations. In all the experiments it appeared that, with equal nerve excitation, the strength of the skin-currents depended on the degree to which the part of the skin bearing the electrodes was furnished with sweat-glands.

New Submarine Cables.—The *Journal Télégraphique* announces that the concession granted to the Pedro Segundo Telegraph and Cable Company having been revoked, the Governor of Surinam, on September 18th, granted a concession to the Société Française des Télégraphes Sous-Marins. Within eighteen months from the date of the granting of the concession Paramaribo is to be connected by one or more cables with some point on the system of the Société Française, and as soon as a concession has been obtained from the French Government, a cable is to be laid between Paramaribo and Cayenne. The tariff between Surinam and various places will be as follows:—Venezuela, 6fr.; Curaçao, 5fr.; St. Dominica, 4fr. 50c.; St. Domingo, 5fr.; Martinique, 2fr.; Guadaloupe, 2fr. 50c.; New York, 8fr.; Cayenne, 1fr. Official messages will be taken at half-rates. The Government of Surinam will, moreover, levy a tax of 10 centimes per word on all messages sent to or from that colony. The Société Française will receive an annual subsidy of 50,000fr., and the concession is to last 60 years, during the first 20 of which no other concession may be granted by the colonial authorities.

The Stuhl Electrical Alarm Thermometer.—The action of most electrical alarm thermometers consists in causing the expansion of the mercury to complete the alarm circuit by coming in contact with a platinum wire connected across the tube of the instrument at the required height. The disadvantage of these thermometers is that they can only be used to indicate one temperature, and the following arrangement has been devised by M. Stuhl to overcome this defect:—Below the thermometer-scale, but above the bulb, he places a glass ball, which only offers a capillary passage to the expanding mercury; one end of the alarm circuit is permanently in contact with mercury in the bulb, the other end of the circuit terminates immediately underneath the glass ball. To set the thermometer it is only necessary to heat it to the required temperature, and then allow it to cool. A portion of the mercury has by this operation been forced past the obstacle, and remains there; the rest of the mercury on cooling sinks into the bulb. Whenever the mercury again expands and touches the platinum contact under the glass ball, a battery and bell in the alarm circuit results in the ringing of an alarm. If it is required to make the alarm ring at a higher temperature, the mercury has only to be heated to that degree. If an alarm is wanted at a lower temperature, the mercury above the ball must be made to fall into the bulb by giving the thermometer a sharp twisting motion.

Earth Currents.—In a Paper read before the Naples Academy of Sciences, Signor Palmieri gave an interesting account of some earth current phenomena recently observed by him in connection with an ordinary overhead telegraph line, five miles long, running from Resina to the Vesuvius Observatory, *i.e.*, from S.W. to N.E. Previous observers have noted the fact that in wires placed in the magnetic meridian, the direction of the earth current was from north to south, and in wires placed equatorially from east to west. Accordingly in the wire experimented on by Signor Palmieri the current *ought* to have been from N.E. to S.W., instead of from Resina to Vesuvius as was the case. Matteucci has observed that in wires inclined at an angle to the horizon, the earth currents are always in an upward direction. Now the difference in level between Resina and the Observatory was nearly 2,000ft. Signor Palmieri, therefore, extended the line from the Observatory in practically the same direction for a distance of nearly 200 yards, and earthed it on the reverse slope of the mountain 52ft. below. If the new line were earthed at the Observatory, the galvanometer showed that a current of less intensity but opposite in direction to the Resina-Vesuvius current was flowing in the wire. If the Resina-Vesuvius line were joined up to the extension line, the earths now being at Resina and at the point 52ft. below the Observatory on the reverse slope of the mountain, the galvanometer deflections were found to be proportional to the algebraical sum of the current intensities. Signor Palmieri concludes his remarks by pointing out that previous observations which did not take this phenomenon into account are entirely vitiated.

The Action of a Long-Continued Electric Discharge on Iodine.—In a Paper recently read before the St. Louis Academy of Science Mr. C. Luedeking describes some experiments undertaken by him for the purpose of studying the effects of the electric discharge on iodine vapour, when continued over a long space of time. The researches of V. Meyer showed that with increasing temperature the vapour density of iodine becomes rapidly less than what is demanded by theory, finally reaching two-thirds of the theoretical value. Later, J. J. Thomson showed that the silent discharge produces the same phenomena of anomalous densities that were observed by V. Meyer for high temperatures. For the purpose of his investigations Mr. Luedeking employed four Grove cells energising a 2-in. spark Ruhmkorff coil. The wires of the coil were connected with heavy platinum wires, sealed in a small, heavy glass tube, with their ends opposite and ½-in. apart from one another. In this tube, 0·036 grm. of iodine was sealed hermetically. By gentle heat it was then vapourised in part. The spark was now passed incessantly for three weeks, day and night, and the character of the light phenomena watched as carefully as possible. As the experiment advanced, the colour of the contents of the tube gradually changed, losing the rich deep violet tint that it had at first, very much resembling bromine vapour in appearance, and passing through this stage, becoming more and more faint, until, at the end of the afore-mentioned time, the tube was entirely colourless, and evidently all iodine had disappeared. The platinum poles were much corroded and roughened; during the discharge, the ends were constantly at a bright red heat; the spark itself had a livid appearance, was uncertain in its course, changing frequently. The sides of the tube were affected as if by hydrofluoric acid. Mr. Luedeking attributes the disappearance of the element iodine to its uniting with the constituents of the glass, and he thinks that under the influence of the electric discharge iodine certainly acquires superior chemical affinities, attacking the substance of the glass, and forming iodides, and probably also some iodates.

Digitized by Google

MAGNETISM IN IRON AND OTHER METALS.*

BY PROF. J. A. EWING, F.R.S.

V.

(*Continued from page 313.*)

§ 27. Distribution of Free Magnetism in the uniformly magnetised Ellipsoid.—Within the ellipsoid the lines of force **H**, of magnetisation **I**, and of magnetic induction **B**, lie, as in Figs. 7 and 8, straight and parallel to the lines in the undisturbed field. Since the magnetisation is uniform the free magnetism resides wholly on the surface. To see how it is distributed over the surface we have to remember that **I** is the surface density of free magnetism per square millimetre on every part of an imaginary *surface formed by taking an end*

Fig. 9.

elevation of the ellipsoid—that is to say, by projecting it upon a plane which is perpendicular to the direction of magnetisation. We may therefore obtain a diagram showing the true surface density of free magnetism on the actual surface of the ellipsoid, by supposing the ellipsoid shifted through a very small distance in the direction of magnetisation, so that a meniscus is formed on either side of the middle, between the old and the new positions. Then the thickness of the meniscus is proportional to the surface density of the free magnetism. Thus in Fig. 9 the original ellipsoid is C A C′ A′. By shifting it through the small distance C D or C′ D′, we get the positive meniscus C′ D′, which is a diagram of the surface density of positive free magnetism on one half, and the negative meniscus C D, which in the same way represents the negative free magnetism on the other half. The free magnetism, though densest at the ends, extends towards the middle, and it is only at the equatorial line that there is none. It is easy to show, by referring to the geometrical properties of an ellipsoid, that the distribution which has been described results in making the total quantity of free magnetism on any narrow zone taken perpendicular to the direction of magnetisation proportional to the width of the zone and to its distance from

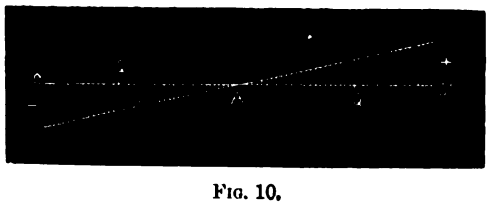


Fig. 10.

the equator A A′. In other words, what we may call the linear distribution of free magnetism in the direction of the axis C C′ is correctly represented by the height of the lines above and below C C′ in Fig. 10.

Again, in regard to linear distribution, it follows that what we may call the centre of the negative magnetism is at Q, two-thirds of the distance A C from A, and the centre of the positive magnetism is at Q′, two-thirds of the distance A C′ from A. The distance Q Q′ is two-thirds of C C′, or $\frac{4}{3}c$.

§ 28. Moment of Ellipsoid.—The whole quantity of positive or of negative magnetism is $\pi a^2 \mathsf{I}$—namely, **I** multiplied by the area of the equatorial section, which is a circle in the special case we have taken, the case of an ellipsoid of revolution with $a = b$. On *distant* external points the action of the magnetised ellipsoid will be the same as if this quantity of positive magnetism were gathered at Q, and an equal quantity of negative magnetism at Q′. The magnetic moment of the ellipsoid is therefore

$$\pi a^2 \mathsf{I} \ \overline{\mathrm{Q}\mathrm{Q}'} = \frac{4\pi}{3} a^2 c \, \mathsf{I}.$$

But we might have obtained this result more directly. Since **I** is by definition the moment per unit of volume (§ 7), and the volume of the ellipsoid is $\frac{4}{3}\pi a^2 c$, the moment is $\frac{4}{3}\pi a^2 c \, \mathsf{I}$, as above.

§ 29. Application to the Case of a Sphere.—When c is equal to a, the eccentricity e is 0, and the ellipsoid becomes a sphere. We then have the case of which Figs. 5 and 6 furnish illustrations. The sphere is uniformly magnetised, but even when the material of which it is made is exceedingly permeable, the magnetisation is by no means strong, because the free magnetism which becomes developed on the surface causes the true magnetic force **H** in the interior to be much less than the original magnetic force **H′** due to the external field.

By applying the general formula of § 26 to find the value of **N** in the expression

$$\mathsf{H} = \mathsf{H}' - \mathsf{N}\,\mathsf{I},$$

it may be shown that for a sphere $\mathsf{N} = \frac{4}{3}\pi$, so that

$$\mathsf{H} = \mathsf{H}' - \frac{4\pi}{3}\mathsf{I}.$$

Dividing by **H** we have

$$1 = \frac{\mathsf{H}'}{\mathsf{H}} - \frac{4}{3}\pi\frac{\mathsf{I}}{\mathsf{H}} = \frac{\mathsf{H}'}{\mathsf{H}} - \frac{4}{3}\pi\kappa.$$

Hence, the proportion which the true magnetic force **H** bears to the force in the undisturbed field is

$$\frac{\mathsf{H}}{\mathsf{H}'} = \frac{1}{\frac{4}{3}\pi\kappa + 1}.$$

This shows that when the material is very susceptible, so that κ is large, the true force **H** is only a small fraction of **H′**. To take a practical instance, the susceptibility of soft iron to weak magnetic forces, such as those produced by the earth's field, is about 20. Assigning this value to κ, we have $\frac{\mathsf{H}}{\mathsf{H}'} = \frac{1}{85}$ approximately. Thus the true magnetic force within a spherical ball of soft iron placed in the earth's field is only about the $\frac{1}{85}$th part of the force in undisturbed parts of the field, and the magnetisation **I** which the ball will take up is only about $\frac{1}{85}$th of that which would be taken by a very long rod of the same material set lengthwise in the direction of the lines of terrestrial magnetic force.

Again, as to the magnetic induction in the sphere and its relation to the permeability, we have (remembering that the permeability $\mu = 4\pi\kappa + 1$)

$$\mathsf{B} = \mu\mathsf{H} = \frac{\mu\mathsf{H}'}{\frac{4}{3}\pi\kappa + 1} = \frac{3\mu}{\mu + 2}\mathsf{H}'.$$

When μ is exceedingly large, the factor $\frac{3\mu}{\mu+2}$ approximates to 3. Hence, in a sphere of very permeable material, the number of lines of induction through the sphere (per square centimetre of section) is nearly three times the number of lines in the undisturbed field. This is the case in the sphere of Fig. 6 (the proportion of the closeness of the lines inside to that of the lines outside at a distance from the sphere being $\sqrt{3}$ to 1, as seen on the plane of the diagram). The student should note that when the permeability of the sphere is great, its exact value has very little influence on the number of lines of induction that pass through the sphere, and hence a spherical ball would be a very bad form of body to select if we wished by measuring the induction to determine the permeability of the material. A small error in the form of the sphere would, in fact, have more influence in altering the amount of the induction than a large difference in the value

* All rights are reserved.

Digitized by Google

of μ or of κ; so that, as Prof. Chrystal has well put it, the experimenter would be testing the accuracy of his instrument-maker rather than the magnetic susceptibility of his material.*

§ 30. The same objection would apply, though in a slightly less degree, to a *short* ellipsoid. By way of illustrating this further, Fig. 11 has been drawn to show in a general manner the induction through an ellipsoid, and the distortion which it produces in an originally uniform field, when the axes have the proportion of 4 to 1, the material being assumed to have indefinitely great permeability. With this proportion between the axes, N, by the formula (1) of § 26, is 0·246, and for every line of force (per square centimetre) in the undisturbed field there are 13·3 lines of induction (per square centimetre) within the ellipsoid. The space between the lines within the body is therefore narrower than the space between the lines in any distant part of the field in the proportion of 1 to $\sqrt{13·3}$. The permeability might vary widely without materially affecting the amount of induction, and the figure may be accepted as representing very nearly what would happen if the ellipsoid were of soft iron.

§ 31. **Application to the Case of a Long Cylindrical Rod of Circular Section Magnetised Transversely in a Uniform Field.**—This case, of which an example is furnished by a long wire stretched in the earth's field in a direction perpendicular to the lines of force, is deducible from the general case of the ellipsoid by making one of the axes infinite. This gives $N = 2\pi$, so that $H = H' - 2\pi I$.

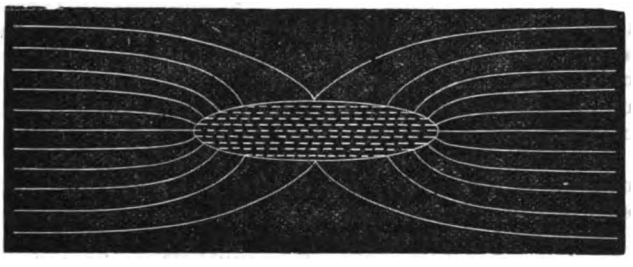


FIG. 11.—Short ellipsoid of infinitely permeable material in a uniform field.

Hence, $\frac{H}{H'} = \frac{I}{2\pi\kappa + 1}$, and $\frac{B}{H'} = \frac{2\mu}{\mu + 1}$.

Thus, when μ is very large, as it is in soft iron, the transverse induction B across the wire approximates a value which is twice that of the external field. This is a very small induction compared with that which the same wire would take longitudinally if it were set lengthwise instead of crosswise in the field (compare § 15 above). If we assume κ to be 20, the proportion of the induction in the two cases is about 1 to 127.

It follows from this that when we hang a wire vertically in the earth's field, the transverse magnetisation due to the horizontal component of the earth's field is so small that account need not in general be taken of it, and the same thing is true of the transverse magnetisation of a wire laid horizontally in the earth's field.

§ 32. **Case of a Thin Disc Magnetised in the Direction of the Thickness by a Uniform Field.**—We may find the true magnetic force within a disc or large thin plate magnetised normally in a uniform field from the fact that the lines of induction B within the disc are continuous with the lines of force H′ in external space, and if the disc is very wide in comparison with the thickness, the lines go straight through it without sensible distortion. Thus $H' = B = 4\pi I + H$, so that $H = H' - 4\pi I$, $\frac{H}{H'} = \frac{I}{\mu}$, and the induction within the disc is the same whatever be the permeability of the material.

§ 33. **Long Ellipsoid: Influence of the Length on the Magnetising Force.**—Returning now to the general case of a long ellipsoid of revolution placed longitudinally in a uniform magnetising field, it is interesting to notice to what extent the uniform magnetisation of the ellipsoid itself affects the magnetic force, when we assume various values as the ratio of length ($2c$) to transverse diameter ($2a$).

In the formula

$$H = H' - NI,$$

we may write $\frac{B - H}{4\pi}$ for I (by § 13), and if the material is very permeable, so that B is large compared with H, this will be very nearly equal to $\frac{B}{4\pi}$ simply. Hence in an ellipsoid made of very permeable material, such as iron,

$$H = H' - \frac{N}{4\pi} B, \text{ very nearly.}$$

The following values of N and also of $\frac{N}{4\pi}$ have been calculated by means of the expressions in § 26 for ellipsoids in which the ratio of length to breadth is 50, 100, 200, 300, 400, and 500 respectively.

Ratio of Length to Breadth $\left(\frac{c}{a}\right)$	N	$\frac{N}{4\pi}$
50	0·01817*	0·001446
100	0·00540	0·000430
200	0·00157	0·000125
300	0·00075	0·000060
400	0·00045	0·000037
500	0·00030	0·000024

* The approximate formula (2) of § 26 gives 0·01812. For the longer ellipsoids the values of N calculated from it may be taken as correct.

Since $H = H' - NI$, $\frac{H'}{H} = \frac{NI}{H} + 1 = N\kappa + 1$. The proportion which the resultant force H bears to the original force H′ in the undisturbed field,

$$\frac{H}{H'} = \frac{1}{N\kappa + 1}.$$

By the help of the above table it is easy to find this proportion, for an assigned ratio of length to breadth, when the susceptibility of the material is known.

As an example we may take $\kappa = 200$ as a representative value of the susceptibility in soft iron when subjected to a moderately strong magnetic force. Suppose that the ellipsoid is 100 diameters long, then

$$\frac{H}{H'} = \frac{1}{0·0054 \times 200 + 1} = \frac{1}{2·08}.$$

In other words, the magnetic force actually operative within the metal—as reduced by the magnetism of the piece itself—is in that case rather less than one-half the force due to external causes.

§ 34. **Residual Magnetism and Retentiveness.**—When a piece of any one of the strongly magnetisable metals—iron, steel, nickel, or cobalt—is magnetised by applying magnetic force, and the externally-applied force is then withdrawn, it is found that the magnetisation does not wholly disappear. What remains is usually called the residual magnetism, and metals which retain residual magnetism when the external magnetic force is withdrawn are said to possess retentiveness.

We shall see later that this retention of residual magnetism, when the externally applied magnetising force is withdrawn, is only one instance of a general tendency which these metals exhibit to resist any change in their magnetic state.

§ 35. **Self-Demagnetising Force.**—In connection with the subject of retentiveness it is of the first importance to notice that though the externally applied magnetic force be withdrawn from a magnetised piece, there is in general some magnetic force in action. This force is due to the residual magnetism itself, and its tendency is to *reduce* the residual magnetisation. In a bar magnet, for instance, the residual magnetism at and near the ends of the bar produces a magnetic force acting in the direction of the length and tending to demagnetise the bar. In a ring magnet uniformly magnetised we get rid of this self-demagnetising force by having the ends, so to

* Article "Magnetism," *Encyc. Britannica*. Ninth Edition

Digitized by Google

speak, brought together. In an exceedingly long bar the self-demagnetising force becomes insignificant because the ends are far removed from most parts of the bar. The residual magnetism in a ring or a very long rod will therefore be greater, other things being equal, than in a short rod. Indeed, so much is this the case that, in dealing with soft annealed iron, we shall find almost no residual magnetism if we experiment with rods the length of which is only 10 or 20 times their diameter, because in these rods the self-demagnetising force is sufficient to remove the residual magnetism almost completely, whereas a rod 400 or 500 diameters long will be found to retain a very large proportion of its induced magnetism when the inducing force is withdrawn. Hence the term residual magnetism has one meaning when it is used to describe the magnetism that remains when magnetic force is completely withdrawn without any reverse force being applied, an experiment which can be made if we use an exceedingly long rod or a ring magnet; and it has another and quite different meaning when it is used to describe the magnetism which a baror other short piece will retain in opposition to the demagnetising force which it exercises upon itself.

§ 36. **Self-Demagnetising Force in Ellipsoids.**—In the case of an ellipsoid, uniformly magnetised, the self-demagnetising force is uniform throughout the body, and its value is

$$\mathsf{N}\,\mathsf{I},$$

where **N** has the same meaning as in § 26 and **I** is the *residual* intensity of magnetisation.

To get an idea of what this may amount to in actual cases, we may take 1,000 C.-G.-S. units as a residual value of **I**, which is commonly enough found in the magnetisation of iron. When an ellipsoid is 200 times as long as it is broad the value of **N** is 0·00157 (by § 32), and a residual intensity (**I**) of 1,000 would therefore produce a self-demagnetising force of 1·57. The experimental results which will be given later will show that a force of this magnitude is by no means insignificant, and that it would, in fact, be sufficient to remove a large part of the residual magnetism. It is only when the length is as much as 400 or 500 times the transverse diameter that the self-demagnetising force in a material so susceptible as iron becomes nearly negligible.

(To be continued.)

UNDERGROUND MAINS.

BY G. L. ADDENBROOKE.

IV.

(Continued from page 315.)

Mr. Crompton's System of Mains and Conduits.

Mr. Crompton, with his usual energy, has made a vigorous and carefully-thought-out attempt to satisfactorily solve the question of distributing electricity, more particularly at low pressures, though there is no reason why his system, with some modifications, should not be useful and convenient for high pressures also.

Like most things of the sort, this system has been gradually led up to and perfected as the result of a long series of observations and experiences. When starting the Kensington Central Station Mr. Crompton was at the outset favoured on the Kensington Court estate itself, which is a large square of handsome modern residential houses, by the presence of a subway all round and next the houses. It was determined to light the houses by bare mains run on insulators attached to the sides of this subway. These insulators were made of china and glass, and had a notch in the top to take a flat strip of copper edgewise. And here came the first difficulty. A flat strip of copper, however carefully rolled, will have in long lengths many uneven tensions in it between the two opposite sides of its breadth, and consequently when standing on its edge is almost certain to buckle about and refuse to lie straight. Even when iron carriers were used on the top of the insulators instead of the notches in the glass, the strip still proved refractory. It was then determined to let the strip have its way, so to speak, and to lay it flat. When this was done, most of the troubles vanished; and it was found that the strip could be got to lie quite even and straight in properly-shaped notches in the top of the insulators. This, then, was the beginning of the system. The bare copper strips were cheap, and worked well; and it was determined to try and extend the method when the mains were run over a larger area, and had to be carried under the pavements and roadways instead of being fixed to the side of a subway.

The first requisite was to form the conduit, and that is done in this way: The pavement of the footway is taken up, and the ground excavated to a depth of 18in. or 2ft., when circumstances will allow, or, if they do not, to a depth of 10 or 12in. only, which is all the room which can be got in places. A long trench about 15in. broad is then formed of concrete, carefully levelled and as straight as possible, the curves, where such exist, in the line of the street being got round by two straight lines of conduit meeting at an angle, where a manhole is placed, and not by forming a curve in the conduit. This concrete conduit is, when properly set, lined with cement, making a very smooth, neat, and watertight job. The cover of the conduit is usually formed by laying paving stones across the top, the joints of which are carefully made with cement, the ordinary paving stones of the footpath being laid on the top of them with a little packing between.

Manholes are required at frequent intervals, at the corners of streets, when the mains cross a road, at certain intervals when the conduit is straight, and usually where connection is made to a house. These manholes are simply square openings in the conduit fitted with an iron frame having a groove round the bottom of the inside, which is packed. Another iron frame fits into this, having a projecting rim at the bottom which falls into the packed groove in the outer frame and keeps the manhole practically watertight. The inside of the frame of the lid is filled with concrete like the G.P.O. manholes, so that to an unobservant person they are hardly distinguishable. It is found that no water to speak of gets into these conduits, and if it does it is of such a moderate quantity that it can be baled out at intervals without difficulty. When the conduit is on a long incline and water tends to accumulate at the bottom, Messrs. Crompton and Co. place a small sump at the side of the manhole, in which the water collects. They state that in their whole system of mains at Kensington, there is only one place where the water continually collects, and here it simply requires a few quarts to be baled out once a week. The conduit being usually under the footpath, while the gas and water mains are in the roadway, only the local connections to the houses are come across as a rule. When these interfere with the line of the conduit, they of course have to be diverted either under or over it, but this with the small pipes is not a difficult matter.

There are, of course, a number of places, such as street crossings, &c., where it is impossible, from want of space and other reasons, to build this conduit; and here Mr. Crompton makes use of 1½in. screw-jointed iron pipes, as many separate pipes being run as he proposes to put lines of conductors in his conduit. Carefully-insulated cables are then drawn through these tubes and joined to the conductors at either end.

We now come to the way the mains are run in these conduits. At convenient distances stout oak cross-bars are fixed across the conduit at a short distance from the bottom, as shown in Figs. 6 and 7, the first of which shows a vertical section of the conduit, the second a horizontal view looking from above. These oak bars have holes bored in them forming sockets, into which drop the lower projecting portion of the glass insulators shown in the figure. Each glass insulator is thus kept firmly upright and in its place, but can easily be withdrawn and another one substituted if necessary. It will be noticed that the insulators have a very large insulating surface, which is further improved by the insulator being carefully dried and dipped in copal varnish before it is used.

The bare copper strip which is now run on these insulators is usually about 1in. broad by ¼in. thick, and can be got from the makers in lengths of some 700ft. By experiment, Mr. Crompton finds that it is quite easy to run this strip in the conduits with a distance between the insulating supports of

Digitized by Google

from 48ft. to 70ft., when proper means are used for straining the strip taut at intervals. With this distance between the supports it is easy to fix a manhole at each of them, so that the strip can be guided into its proper place by hand. The groove in the insulator is deep enough to take two or three strips one on the top of the other, but in such a case where several strips are required, it is found more convenient to pull in two or three new strips at the same time, than to pull another strip over the top of existing ones.

The method of straining the strips will be readily seen from the figures. Fig. 8 shows a side view of the strainer. Two oak bars are fixed one above the other across the conduit, and

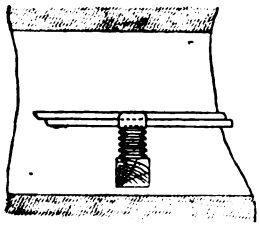


Fig. 6.—Crompton System. Method of Running the Conductors in the Conduit. Vertical Section.

in these glass insulators are fixed. Fitting on the top of these insulators is a bronze bridge with a slot through the centre and two tightening screws. The strip or strips are carried through this slot and strained tight by a special tool made for the purpose. While thus strained taut the tightening screws in the bridge are screwed down on the top of the strip, holding it firmly in its place. Fig. 9 shows a horizontal view of a man-

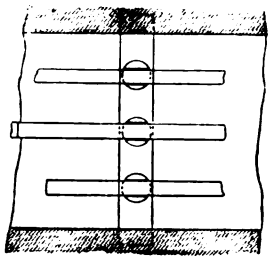


Fig. 7.—Crompton System. Method of Running the Conductors in the Conduit. Plan.

hole with three lines of mains coming into it and held by bridges. One strip is fastened to another or a cable running under a roadway to a strip by strong clamps without the use of solder.

The house connections from the conduit are usually made by means of indiarubber-covered wires laid in 1½in. gaspipe, and clamped to the bare main which runs past. A manhole

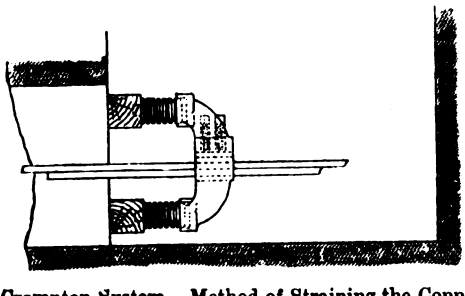


Fig. 8.—Crompton System. Method of Straining the Copper Strips. Side View.

for making this connection and getting at it is placed opposite the party wall of every other house, so that the house can be got at from the same manhole.

In some places it may be inconvenient in a conduit to use fixed insulators, or it may be advisable to substitute good-sized iron pipes for the conduit. To meet such cases Mr. Crompton has devised a special form of carriage insulator mounted on an insulated trolley running on wheels, so that the conductors, being fixed to the first trolley, can be drawn into the conduit or pipe, and additional trolleys be added as the conductors are pulled along at the distance requisite to keep them from touching the bottom or sides. Such a system does not require man-

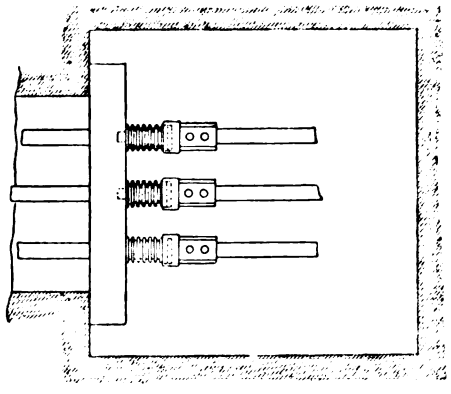


Fig. 9.—Crompton System. Horizontal View of Manhole with Three Lines of Mains coming into it.

holes over the insulators, and of course the conductors are easily withdrawn at any time. The two figures, Nos. 10 and 11, show a side and end view of the trolley as arranged for use in a square conduit. Its action will readily be seen. At each

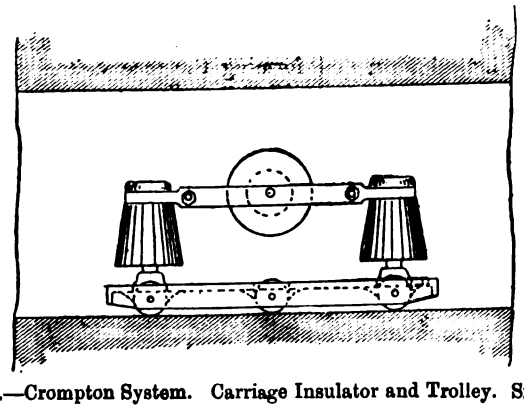


Fig. 10.—Crompton System. Carriage Insulator and Trolley. Side View.

end of the trolley are insulators. To the necks of each pair of these longitudinally a metal bridge is clamped. The bridge carries a deeply-flanged roller in its centre, in which the strip or strips lie. When used with pipes the trolley wheels are set at an angle, and a very ingenious arrangement has been devised for getting the trolleys to carry the strip properly round a gentle curve.

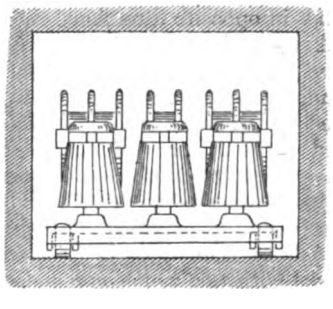


Fig. 11.—Crompton System. Carriage Insulator and Trolley. End View

As regards the insulating qualities of this system, they are certainly ample. Even when very damp the leakage over the surface of the insulators is very small and of a perfectly harmless character. The weakest point is where a cable is joined to a strip, but by arranging the junction properly, and carefully treating the end of the cable, the chances of any serious leakage are practically *nil*.

Digitized by Google

Underground Wires in Paris.

Le Genie Civil, in describing the electric light plant at the Halles in Paris, gives an account of the methods used in laying the wires under ground, from which we condense the following description:—The Municipal Council authorised the use of the sewers, but in spite of this the engineers have preferred to build special conduits. The cables, therefore, have been placed under the sidewalks in conduits of the form shown in Fig. 12, made of cement and 10·23 × 11·80in. in size. Wooden supports furnished with glass holders, which carry the cables, are placed at distances of 4·92ft. apart. These wooden supports slide freely in grooves made in the conduit, and thus form a method of suspension easily accessible for repairs. In crossing the streets, where the soil is very damp and permeable, cables are sunk one meter below the surface.

For the circuit at low tension the cables are made as follows: The wires are twisted together and covered with a layer of pure rubber; then with a layer of mixed rubber at least 2mm. (0·08in.), and finally by two bands of cotton impregnated with rubber. The whole cable is vulcanised in a compact mass, and is then protected by an outer covering of hemp soaked in rosin or tar.

For the high-tension circuit, on account of the narrowness of the sidewalk in certain streets, it was necessary to use, for a short distance, the sewers, and in order to avoid any disturbance of the telegraph and telephone wires on these sections, use was made of concentric cables. These cables were thus formed: A core of 19 copper wires of 2mm. (0·08in.), giving a section of 60 sq. mm. (9·3 sq. in.); the wires outside were covered by two layers of pure rubber 1mm. (0·04in.) in thickness, and then by several layers of vulcanised fibre wound in different directions; outside of this was a series of copper wires rolled in helical form and forming the second circuit, having the same total section as the core. These were covered in

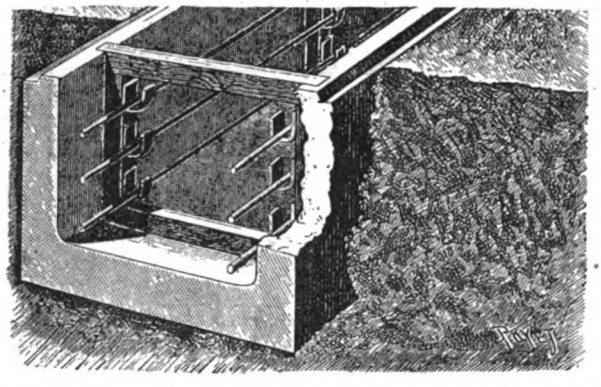


Fig. 12.—Conduit employed in connection with the Municipal Station at the Halles Centrales, Paris.

turn, first by two layers of pure rubber, then by several layers of vulcanised rubber 3mm. (0·12in.) thick, then by two vulcanised bands wound in opposite directions, then by hemp 3mm. (0·12in.) in thickness and saturated by a resinous composition, and then by two bands of vulcanised cotton. The whole was enclosed in a leaden pipe 2·5mm. (0·10in.) in thickness, which again was covered by twisted cord. This cable rests on wooden supports fastened in the masonry of the sewer.

For the ordinary high-tension cables the conduits are similar to those for the low-tension cables described above. The degree of insulation was carefully provided for in the specifications. These cables rest on wooden supports injected with sulphate of copper and covered with tar, which rest on porcelain insulators in the cement conduits. At the crossings of the streets the conduits are arranged as mentioned above.

The total length of 2,952ft. of concentric cables in the sewers and 19,024ft. of the ordinary cables was put down at a cost of about £3,000. The current furnished from the light station is sent out under a pressure of 2,400 volts. As it is furnished to each user under a tension of 100 volts, it is necessary to use transformers between the main circuits and each side connection.

(To be continued.)

THE THOMSON-HOUSTON ARC LIGHT SWITCHBOARD FOR CENTRAL STATIONS.

Of all the appliances used in the operation of arc light machines, says the *Electrical World*, from whom we take the following particulars, there is nothing of greater importance than a well-designed switchboard. There are but few central lighting stations in which commercial and street lights are not operated, making it necessary, for convenience and economy, to place two or more circuits in series on one dynamo, to transfer circuits from one machine to another, and to make such combinations of dynamos and circuits as local conditions render necessary. It is most desirable that there should be no extinguishment of the lights while these changes are being made, and that the construction of the board be such as to insure the operator against receiving a shock while so doing. The switchboard here shown (Figs. 1 and 2) meets these requirements, is incombustible, and is of such construction that additions can be readily made without necessitating any changes in the part of the board having the circuits already in position.

As will be seen from the illustrations, the board is made of two rectangular slate slabs, placed about five inches apart, into which are fitted rows of metal bushings, those arranged

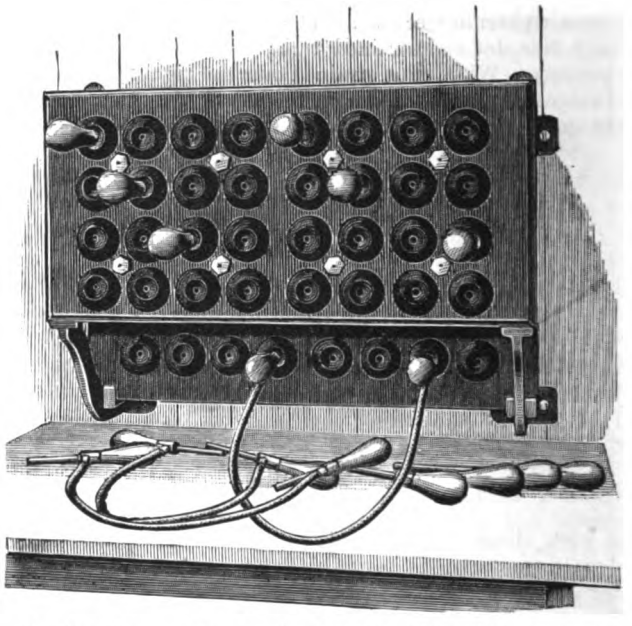


Fig. 1.—Thomson-Houston Arc Light Switchboard (front view).

horizontally on the front board being connected to the dynamos, while the vertical rows on the back are connected to each other and the circuits. On the back there is one more row of bushings than on the front, this extra row being used to connect one circuit with another by means of the transfer cables and plugs.

The switchboard is made for four and six circuits, and is so arranged that additions may be easily made by which the number of dynamos and circuits will be a multiple of four and six. The positive and negative terminals of the dynamos are connected to the left and right side, respectively, of the front board, and the circuits on the rear board in a like manner, the left being positive and the right negative, the bushings for the dynamos being numbered vertically 1, 2, 3, 4, while those for the circuits are numbered horizontally 1, 2, 3, 4. To connect a machine to a circuit the plugs are pushed through the holes on both positive and negative sides of the board corresponding to the dynamo and circuit desired.

To connect any two circuits in series on one dynamo before the machine is started, the plugs are pushed through the holes corresponding to positive of one machine and one circuit, and then by means of the transfer cable and plugs at the bottom of the rear board the negative of this same circuit is connected

Digitized by Google

with the positive of the second circuit which it is desired to place in series with the first, the final connection being made by pushing the plug through the hole corresponding to the negative of the second dynamo and negative of second circuit.

To transfer circuits from one dynamo to another when the machines are in operation, without disturbing the lights—as, for instance, transferring circuit No. 1 from No. 1 to No. 2 dynamo—No. 1 dynamo is connected to No. 2 circuit by the plug, and No. 2 dynamo to No. 1 circuit. The circuit can then be broken between the dynamos and circuits No. 1 and No. 2, permitting No. 1 dynamo to be shut down, and the positive of circuit No. 2 connected to negative of circuit No. 1 by means of the transfer cables and plugs.

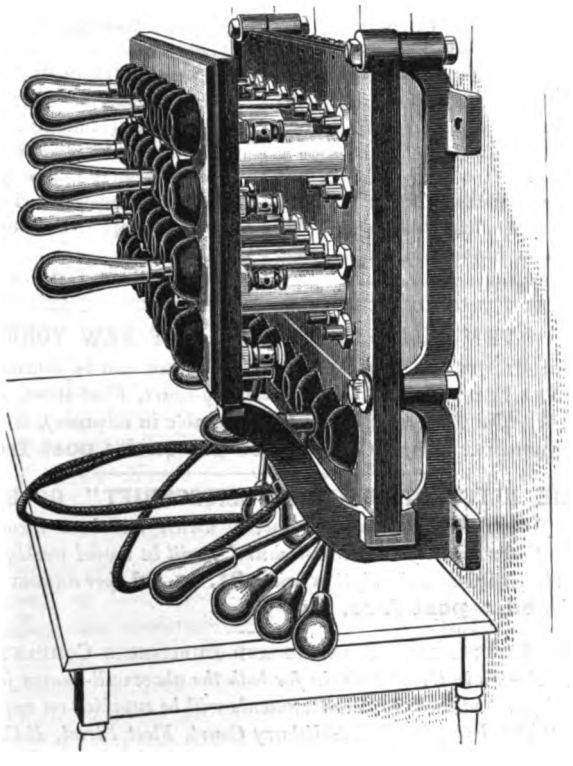


Fig. 2.—Thomson-Houston Arc Light Switchboard (side view).

The wall space required for a four-circuit board is 19 × 25in., and that for a six-circuit board 24 × 35in.

THE MOLECULAR AND ASSOCIATED CHANGES OCCURRING IN IRON AND STEEL WHEN HEATED AND COOLED.

BY DR. G. GORE, F.R.S.

Before the immediate interest of Dr. Hopkinson's Presidential Address on Magnetism has ceased, I beg leave to make the following remarks on one of the essential points of the address, viz., the molecular and other associated changes which occur in iron and steel during heating to redness and subsequent cooling.

In the address, the experiments of Prof. Barrett (*Phil. Mag.*, December, 1873) and the later ones of M. Osmond were very suitably mentioned, whilst earlier ones respecting the very thing, viz., the molecular and associated changes, of which the President was speaking, were omitted. These experiments were described in a Paper on "A Momentary Molecular Change in Iron Wire" (*Royal Soc. Proc*, January, 1869, Vol. XVII., p. 260), "The Development of Electric Currents by Magnetism and Heat" (*ibid*, p. 265), and "Molecular Movements and Magnetic Changes in Iron, &c., at Different Temperatures" (*Phil. Mag.*, September, 1869, p. 170).

In the latter of these papers (p. 172) was, I believe, first published the fact of the sudden molecular change and alteration of length which occur in iron at a red heat, and was first recorded the connection of these changes with the chief magnetic one in iron and steel, and the occurrence of smaller changes of the same kind in those substances. The happening of this molecular change during cooling, as well as during heating, was mentioned (*ibid*, p. 172), and similar small molecular alterations in nickel during heating and cooling were similarly made known (*ibid*, 175-176).

These earlier simple experiments, unaccompanied by precise measurements, appear to have originated a number of allied researches by various investigators. It was by repeating one of these experiments, with the aid of an apparatus furnished by me, that Prof. Barrett was led to discover the phenomenon of recalescence of iron (*ibid*, December, 1873, p. 472). In the Paper on "Molecular Movements and Magnetic Changes in Iron, &c., at Different Temperatures" (*ibid*, September, 1869, p. 177), it had been already stated, as an inference from the results of the experiments, that "simply by heating a bar of iron to redness a whole series of changes occur in its molecular structure, its magnetism, its dimensions, its cohesive power, its specific heat, its thermo-electric capacity, and its electric conducting power." The change of specific heat was subsequently experimentally proved by Prof. Barrett, and each of the other statements has, I believe, been since similarly demonstrated by a variety of researches made by different investigators, including Dr. J. Hopkinson.

As these earlier original experimental facts appear to me to constitute an essential basis of the subsequent researches, and without them no measurements respecting them nor application of them to practical purposes could be made, some notice of them in connection with one of the essential points of the address, viz., the molecular and associated changes, appears to me desirable. The accidental association of my name with those experiments is quite a secondary matter.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To night) FRIDAY, February 7th.

PHYSICAL SOCIETY.

5 p.m. Annual General Meeting. Papers to be read, "On Galvanometers." By Prof. W. E. AYRTON, F.R.S.; T. MATHER; and Dr. W. E. SUMPNER. "On a Carbon Deposit in a Blake Telephone Transmitter." By F. B. HAWES.

INSTITUTION OF CIVIL ENGINEERS.

7:30 p.m. Students' Meeting. Paper to be read, "Reclamation of Land on the River Tees." By COLIN P. FOWLER, Stud.Inst.C.E.

ROYAL INSTITUTION.

9 p.m. Lecture: "The London Stage in Elizabeth's Reign." By HENRY B. WHEATLEY, F.S.A.

MONDAY, February 10th.

LONDON INSTITUTION.

5 p.m. Lecture, "Electrical Phenomena in Nature." By SHELFORD BIDWELL, F.R.S.

SOCIETY OF ARTS.

8 p.m. CANTOR LECTURE II. 4. "The Electro-Magnet." By Prof. SILVANUS P. THOMPSON, D.Sc.

TUESDAY, February 11th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be further discussed: "Bars at the Mouths of Tidal Estuaries." By W. H. WHEELER, M.Inst.C.E.

ROYAL VICTORIA HALL.

8:30 p.m. Lecture, "Arsenic." By WARD COLDRIDGE.

WEDNESDAY, February 12th.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Paper to be read, "Modern Improvements in Facilities for Railway Travelling." By GEORGE FINDLAY.

ROYAL MICROSCOPICAL SOCIETY.

8 p.m. Annual Meeting. Address by the President.

THURSDAY, February 13th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be read: "The Theory of Armature Reaction in Dynamos and Motors." By JAMES SWINBURNE, M.I.E.E.

Digitized by Google

The Electrician.

Published every Friday. Price Fourpence; Post Free, Fourpence Halfpenny
Editorial, Publishing and Printing Offices:

No. 1, SALISBURY COURT, FLEET STREET, LONDON, E.C.

Telephone No. 2714. Telegrams: "Electrician Newspaper, London."

All Communications to be addressed to "The Electrician," *1, Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "The Electrician."

All letters intended for insertion in "The Electrician," *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

"The Electrician" *is published every Friday morning, in time for the morning mails. Subscribers should receive their copies by the first post on Friday morning.*

"The Electrician" *is on sale at the railway bookstalls throughout the United Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices as above*

SPECIAL NOTICE.

Owing to the increase in the number of pages of "The Electrician," in order to partly cover the increased postage, we have been compelled to revise the rates for Foreign Subscriptions, which are now as follows:—

	3 months.	6 months.	12 months
For Foreign Parts and Colonies:—	s. d.	s. d.	s. d.
Within Postal Union	6 6	12 6	24 0
Aden, Borneo, Ceylon, China, India, Japan, Java, Labuan, Mozambique, New Caledonia, Persia, Philippine Islands, Siam, Transvaal, and Zanzibar	7 6	14 6	28 0
The rates for the United Kingdom remain as follows:—	5 0	10 0	19 6

TO ADVERTISERS.

"The Electrician" *offers exceptional advantages to Advertisers.* **It has the largest circulation of any English Electrical paper, and circulates all over the World.**

Particulars relating to Advertisements will be promptly forwarded on application to the office.

Trade Advertisements *intended for the current issue must be handed in not later than First Post on Thursday morning.*

Small Prepaid Advertisements *(for Rates see page xv.) are accepted up to 4:30 p.m. on Thursday.*

TECHNICAL PRINTING.

"The Electrician" Printing and Publishing Company (Limited) *beg to inform Electricians, Electric Light Engineers, &c., that they make a specialty of Technical Printing, and have a Staff thoroughly acquainted with Electro-Technology. They can, therefore, promise Accuracy and Despatch in the Printing of Electrical Catalogues and Electro-Technical Literature generally.*

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.

Royal 8vo.

Early in each year is issued "The Electrician" Electrical Trades' Directory and Handbook. *The Directory was established in 1883, and the 1889 Edition consisted of more than 600 pages of printed matter. The names and addresses of all persons engaged in the Electrical Industries may be relied upon as accurate. Useful Tables and Electrical Formulæ, and information specially compiled for this work are given, together with popularly-written Biographical Notices of the leading Electricians, Electrical Engineers, &c., accompanied in many cases by Portraits.*

The issue for 1890, which is still further enlarged and improved (making 850 pages), is NOW READY. Orders should be forwarded at once to the Publishing Offices, Salisbury-court, Fleet-street, London, E.C.

CONTENTS OF THE CURRENT NUMBER.

Notes 335
Magnetism in Iron and other Metals.—V. By Prof. J. A. Ewing, F.R.S. Illustrated. Continued 340
Underground Mains.—IV. By G. L. Addenbrooke. Illustrated. Continued 342
The Thomson-Houston Arc Light Switchboard for Central Stations. Illustrated ... 344
The Molecular and Associated Changes Occuring in Iron and Steel when Heated and Cooled. By Dr. G. Gore, F.R.S. 345
Meetings of Scientific Societies. 345
The Institution of Electrical Engineers 346
Reviews 347
Physical Society—"On Galvanometers" 348
The Aron Meter 351
The Metropolitan Building Act 352
American Notes 352
Brussels Notes 353
Correspondence—
Training for the Electrical Industry.—Prof. Andrew Jamieson 353
Overhead Wires and the Electric Lighting.—R. S. Bozon 354
Double Break Switches.—Arthur C. Cockburn 354
Trade Notes and Notices 354
Legal Intelligence—
International Cable Company (Limited) 355
Hinds *v.* Smith—Christopher *v.* Same 355
Companies' Meetings, &c.—
Anglo-American Telegraph Company (Limited) 355
Cuba Submarine Telegraph Company (Limited) 357
City of London and Southwark Subway Company ... 358
North Metropolitan Tramways Company (Limited) ... 359
City Notes, &c. 359
Companies' Share List 360

"THE ELECTRICAL WORLD" OF NEW YORK.

"The Electrical World" of New York *can be obtained from* "The Electrician" *Office, Salisbury-court, Fleet-street, London, E.C. The Rate of Subscription (payable in advance), is* **£1 1s.** *per annum. Single Copies* **price 6d. each; post free, 8d.**

"THE ELECTROTECHNISCHE-ZEITSCHRIFT" OF BERLIN.

In future the above journal (with which has been incorporated "The Centralblatt für Electrotechnik") will be issued weekly instead of fortnightly, the subscription being **£1. 4s. 6d.** *per annum. Single Copies* **6d.; post free, 7½d.**

"The Electrician" Printing and Publishing Company, Ltd., *are Agents in Great Britain for both the above well-known journals, and particulars as to Advertisements will be supplied on application to "The Publisher," 1, Salisbury Court, Fleet Street, E.C.*

THE INSTITUTION OF ELECTRICAL ENGINEERS.

Notwithstanding many predictions to the contrary, the growing prosperity of the Institution of Electrical Engineers has been latterly so marked as to call forth the congratulations of its best friends, and to almost silence its severest critics. The little band of telegraph engineers who met in 1872 to found their Society, and of whom Major-General Webber is now the sole survivor, have seen the small seed which they planted and fostered with such assiduous care grow and expand until it has become a flourishing tree. Under its new style and title it is becoming even more popular than in the days when it modestly styled itself the Society of Telegraph Engineers, and its membership is growing by leaps and bounds. In 1888, whilst still nominally a society of telegraph engineers, it added 168 to its already large membership. In 1889, its first year after the reorganisation on a wider basis, it admitted no fewer than 183 new names, and the rush of applications for admission continues. At every meeting from 20 to 30 names are submitted to the ballot, after having passed the preliminary step of consideration by the Council. It is clear that, in the eyes of the electrical profession—and under this term we would of course include the manufacturers and traders in the electrical industries—the Institution has justified its existence, and has proved itself to be a body to which it is an honour to belong. All this means that the Institution is being worked in a way that commands success and respect.

Digitized by Google

The excellence of the Papers read at its meetings, the quality and freedom of the discussions upon them, the promptitude and fulness of the reports issued to the members, not only attract attentive audiences at the meetings but proclaim the advantages of membership. Add to these things the increasing recognition given to the Institution, its influence in the scientific and professional world, the fact that it is consulted from time to time by such bodies as the Board of Trade upon questions that arise affecting the electrical industries, and it becomes evident that the INSTITUTION OF ELECTRICAL ENGINEERS is an association of great and rapidly-increasing power. Other electrical societies, such as the American Institute of Electrical Engineers, the Elektrotechnische Verein, in Berlin, and the Société Internationale des Électriciens, in Paris, may be in a sense equally flourishing. But not one of them commands to-day the influence of our own Institution. In none of them are the proceedings of the same high average order; at the meetings of none of them is it possible to gather together for debate so large a number of distinguished electricians.

Satisfactory as such a position may be, the very magnitude of the present success evokes reflections of another nature than mere congratulation. Can so rapid a growth be healthy? Is it not possible, unless some check is placed upon the present rush for membership, that there may come a serious reaction? Is the Council of the Institution alive to the possible dangers in store from so rapid an influx? Are the persons who are being drafted in by twenties and thirties deserving of membership, or will not some of them weaken the Institution rather than strengthen it? These are questions which may well be asked at the present time.

Consider the advantages of admission. Every member, whether his grade be that of "Student," "Associate," "Foreign Member," or full "Member," has the privilege not only of attending the meetings and introducing his friends, but of receiving the published volumes of the *Journal* of proceedings, the intrinsic value of these being in itself quite equal to the actual sum paid by the mere "Student" member. The Associate or the full member is, moreover, entitled to signify to the world by certain mysterious initials after his name that he belongs to the Institution. Doubtless a not very small percentage of the candidates for admission have an eye to the commercial value of this fact. The half-instructed electrician who desires to pose as a full-fledged electrical engineer aspires to the unassailable dignity of Associate. The enterprising civil engineer, who knows all about gas and water and highways, and sees that vestries and corporations require electrical advisers, also aspires to membership in the one professional body that will entitle him in the eyes of the world to pose as an electrical authority. Far be it from us to decry as unworthy the motives of all candidates for membership: there are degrees of worthiness, and few men are so constituted that their desires in joining a society are absolutely disinterested. But knowing that a few, at least, of the candidates who are rushing into the Institution possess qualifications of an extremely limited kind, it behoves those who have the interests of the Institution at heart to watch the ballot boxes very narrowly lest something of a catastrophe occur. In every society, sooner or later, there arises a crisis of the kind we desire to stave off from our own Institution. Fifteen years ago the Chemical Society went through such a crisis: when after a rush of popularity, during which admission to the fellowship of that society had been granted to a number of persons of very miscellaneous qualification, a small but determined knot of real chemists determined, by unsparing and almost indiscriminate use of the black ball, to reject every candidate who did not come up to their standard of qualification. Through a similar crisis, if we are not mistaken, the Institute of Actuaries is now passing. It is the price—we had almost said the penalty—of success.

All true friends of the Institution must earnestly desire that no such crisis fall upon their organisation to cripple its usefulness, and paralyze its energies by internal bickerings. And the only way to obviate such an undesirable occurrence is to foresee its possibility and to guard against it. Happily our Institution has grades in its membership, and it is always possible to propose for admission to the lower grade of associateship one who, though desirable in that capacity, is not really eligible to be accepted as a full Member. The one important question to be asked on every proposal for membership (assuming always the personal worthiness and integrity of the candidate) is this: Is he really an electrical engineer? If he is only an electrician and not an engineer, or if he is only an engineer and not an electrician, then he ought to be contented with becoming an associate, and ought not to be admitted to the full membership. Of course there are exceptions: there are distinguished engineers—men at the summit of their profession—whose accession to membership in any scientific society does at least as much honour to the society as the society could possibly do to them. But the Institution and its Council cannot be too particular to ensure that, save for special distinction, none are admitted as members of the INSTITUTION OF ELECTRICAL ENGINEERS who are not truly engineers and truly electricians. We have heard it suggested that the power of transferring persons already in the class of "Associate" to the class of "Member," now vested in the Council, should be henceforth vested in the Institution at large, and that all transfers, like all original proposals for membership, should go through the ordeal of the ballot. This is a step of doubtful wisdom: a better plan would be for the Council itself to vote such transfers by ballot, instead of by a mere show of hands at the Council-table. For, in truth, the machinery of the ballot box in the Institution is even now unwieldy, and, if not carefully watched, may be abused. Our warning will not have been in vain if it helps the professional body that watches over the interests of our craft, and with which we all are proud to be associated, in however humble a capacity, to steer clear of one of those quicksands which so often underlie the flood-tide of prosperity.

REVIEWS.

Absolute Measurements in Electricity and Magnetism. By ANDREW GRAY, M.A., F.R.S.E. Second Edition. (Macmillan and Co.)

This is a revised and greatly enlarged edition of the works under the same title, published in 1884, and, unfortunately, long since out of print. It is simpler and less comprehensive than the larger treatise by the same author on "The Theory and Practice of Absolute Measurements in Electricity and Magnetism." It is of a more practical nature, and is designed for the use of students who are not sufficiently equipped mathematically to follow the larger work. The purpose of the book is not so well indicated in its title as in the introductory chapter, wherein it is stated that the main object of the author is to give an account, both theoretical and practical, of the methods of measurement of current and potential in absolute units, and of the application of these to the graduation of instruments for use in practical electrical work.

The second chapter deals very fully with the determination in absolute measure of the horizontal component of the earth's magnetism. The apparatus described is exceedingly simple in character and trifling in cost. The student need have but very little manipulative skill in order to make for himself all that is necessary for carrying out the various experiments. The descriptions given are minute and practical, dimension,

Digitized by Google

and diagrams being supplied, as, for instance, with regard to the manufacture and setting up of the magnetometer and the deflecting magnets. Many sources of error in the measurement are noticed, and the necessary corrections are carefully discussed. We notice on page 28 that, owing to a slip in the formula for the moment of inertia, the equations (10), (11), and (12) are erroneous. The chapter concludes with a detailed description of actual experiments made by Mr. T. Gray to determine the value of H at Glasgow. Next to making experiments for himself, nothing more vividly brings home to the student the reality and simplicity of physical science than the numerical description of actual experiments. This method of teaching might with advantage be much more frequently followed in text books than it is. It is a great pity that Prof. Gray resorts to the use of such ancient expressions as "blue pole" and "red pole." We do not think there is any liability to confusion owing to the fact that the magnetism of the north pole of a magnet is of the opposite kind to that of the north pole of the earth, and, even if there is, matters are not improved by arbitrarily colouring the poles. It would probably be better entirely to cease to talk about poles, and simply refer to the number and direction of the lines of force produced by the magnet. As far as experiment shows, lines of force have a far greater claim to real existence than the imaginary magnetic matter which is assumed to be concentrated near the two points called poles.

The following four chapters deal with the absolute units of magnetic pole, magnetic field, electric current, potential, and resistance. The theoretical and practical considerations which have to be taken into account in the construction of a standard galvanometer are discussed rather fully, and some space is devoted to the theoretical determination of the distribution of current and potentials in derived circuits and in networks of conductors. A long and important chapter follows, describing standard electrical measuring instruments and the methods of graduating them. Mr. Gray's experience in the Glasgow laboratory is, of course, such as to specially qualify him to give authoritative descriptions of all Sir William Thomson's instruments, whether of the laboratory or engineering types. The current balances, the White form of quadrant electrometer, and the electrostatic voltmeters, including the new multicellular ones, are treated at length; and the author then proceeds to discuss the calibration of current meters by the copper deposit method, which has been developed into a satisfactory one by Mr. Thomas Gray's experiments made in Sir William Thomson's laboratory. A good abstract of these experiments is given, the copper voltameters used being illustrated and described. The great importance in modern practice of having properly standardised instruments will render this chapter exceedingly valuable to many readers. The lengthy chapter which follows on the measurement of resistance is much the same as the corresponding one in the author's larger work. The measurement of electrical energy, and efficiency, with especial reference to alternating current circuits, are the next subjects discussed. The theory of alternating current machines is given, as is also an account of Dr. Hopkinson's theory of the working of alternators in series and in parallel. The analytical method is retained, although in our opinion the same results are obtained in a simpler and clearer manner by graphical processes. It is, however, an advance to have the subject introduced into a text book. The importance of impedance and self-induction in connection with alternating current circuits is so great, that the omission of any method of measuring these quantities in a book entitled "Absolute Measurements" is certainly one which should be remedied when a new edition is called for. Methods are given in the next chapter for the measurement of intense magnetic fields, such as are met with in dynamo machines; and the concluding chapter deals with the theory of the dimensions of the units of physical quantities. The author adopts Prof. Rücker's suggestion that the unknown dimensions of specific inductive capacity and magnetic permeability should be indicated instead of being ignored, and in consequence the difference between the electro-magnetic and the electrostatic units, and the transfer from one to the other is, for the first time, made clear to the student. Some useful tables bring the book to a close.

THE PHYSICAL SOCIETY.

At the meeting of this Society held on January 17th, Prof. S. P. Thompson's paper on "Electric Splashes," of which we published an abstract last week, was followed by a Paper

"On Galvanometers,"

by Messrs. W. E. Ayrton, T. Mather, and W. E. Sumpner, which was read by Professor Ayrton, and which will be discussed this afternoon (Friday, February 7th).

The Professor observed that when fitting up the Electrical Laboratories of the Central Institution in Exhibition-road, a large number of galvanometers were obtained, some of which were of novel types specially constructed.

These instruments were subjected to a number of comparative tests by Messrs. Mather and Sumpner, and students working under their direction; and he was of opinion that a record of the results obtained would be of value, as affording data for the selection of instruments most suitable for the objects in view, as well as offering suggestions for future improvements in the manufacture of galvanometers.

The first question which arose was whether it was always advisable that sensitive galvanometers should be astatic. Prof. Gray, in his treatise on Absolute Measurements in Electricity and Magnetism, maintains that it is not, observing that while sensibility is sometimes obtained by the astatic construction, it is rarely necessary, and such instruments give more trouble than single-needle galvanometers. The Professor observed that Mr. Gray's opinion carried special weight, as it might be taken as practically expressing Sir William Thomson's views on the subject. Sir William had, indeed, himself expressed the opinion that the best method was to employ a single needle and weaken the magnetic field as far as requisite by means of controlling magnets. Theoretically there was no limit to the sensibility obtainable in this manner, but the practicable limit

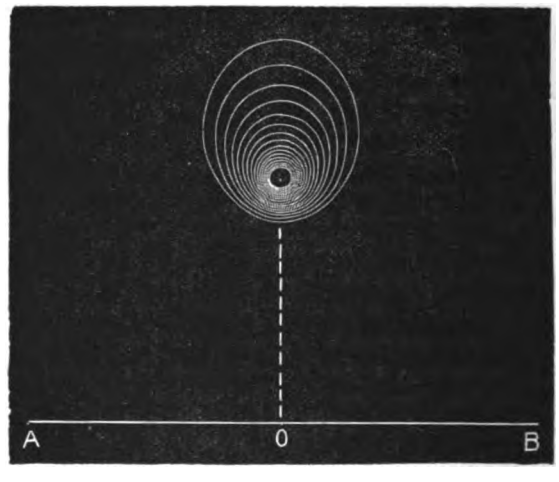


Fig. 1.

due to instability was reached sooner with non-astatic galvanometers than with astatic ones. Another important advantage of astatic over non-astatic instruments was their much greater freedom from external magnetic disturbance, and the resulting increased stability of the zero point. These were very important advantages in favour of the astatic construction, and in view of these facts the authors could not admit that astatic instruments were more troublesome to work with than non-astatic ones—the reverse being in their opinion the truth, on account of the comparative freedom from external disturbance.

It was then pointed out that in the ordinary method of constructing astatic galvanometers some of the most valuable portion of the coil was cut away to provide a space for the magnetic needle and mirror. Mr. Mudford, while a student at the City Guilds Institute, had suggested that the needle only should be placed within the coils and the mirror outside, or when four coils were employed, between the two pairs. This suggestion was submitted to Sir William Thomson, who considered it a good one, and some instruments constructed in this manner were exhibited at the meeting, and it was stated that they had proved extremely satisfactory. When this arrangement was adopted it was not necessary to leave even a small gap right through the coils, as was required when the mirror was in the usual position, to provide a passage for the ray of light.

It was next pointed out that the space left unwound within the coil should be larger than was required simply to allow the needle to turn, for if the winding was carried too close to the needle the effect on the latter of the innermost coils would be opposed to that of the rest of the coil. This is easily seen from Fig. 1, which

Digitized by Google

shows a section of the lines of force, and of the equipotential surfaces, due to a current in a circular conductor, the cross-section of which is shown by the small circle in the centre, having its centre at the point O, and its plane perpendicular to the line A B. The equipotential surfaces are oblate surfaces of revolution having the line A B as their common axis. (*See* Maxwell's "Electricity and Magnetism," Vol. II., Plate XVIII., and Art. 702.) The space to be left unwound was deduced graphically from this figure by drawing the curve passing through the points on the lines of force at which the tangent is perpendicular to the axis.

Taking a point $x\ y$ on this curve, and supposing the radius of the coil to be unity, the co-ordinates $x^1\ y^1$ of a point on the curve representing a section of the critical surface within which the winding should not be continued will be given by

$$x^1 = \frac{x}{y}, \quad y^1 = \frac{1}{y}.$$

A section of the critical surface obtained in this way for one of the coils experimented with is shown in Fig. 2. The longer axis

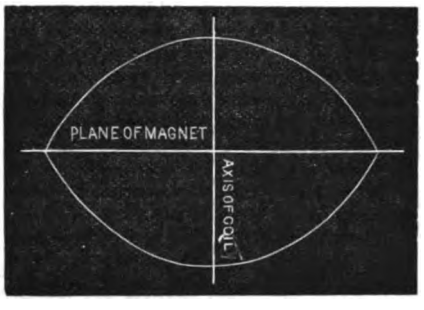


FIG. 2.

of the spheroidal figure was found to be about ·72 of the length of the needle. Mr. Mather had suggested that instead of leaving this space unwound it would be preferable to have it wound in the opposite direction to the rest of the coil, so that no portion of the space in the neighbourhood of the needle should be magnetically useless.

Details as to the methods of supporting the coils were then discussed, and the importance of fitting them in boxes mounted on hinges or otherwise, so as to be readily removable, was pointed out. A galvanometer devised for teaching purposes, and provided with variable damping arrangement, was described, in which the damping is effected by enclosing the mirror in a glass cell whose sides can be caused to approach or recede by turning a milled head outside the instrument. This arrangement enables the damping to be varied between wide limits, and its effect on the swing produced by a given discharge can be determined. The instrument is also serviceable both as an ordinary damped galvanometer or as a fairly ballistic one.

FIG. 3.

In Elliott's old pattern of galvanometer, in addition to the portion of the coils left unwound to admit the light to the mirror, a second portion was similarly left on the lower set of coils to admit the damper, a most objectionable arrangement, and one which did not appear to have any reason whatever in its favour. The method of damping preferred by the authors was to attach the mirror to a long vertical strip of mica or aluminium, across the upper and lower ends of which the magnets were fixed, as shown in Fig. 3.

With this arrangement, with a galvanometer having a vibration period of seven seconds or upwards, the needle did not visibly pass through the zero, or was absolutely dead-beat, and even with one having a very short period it would not do so more than twice.

In measuring quantities of electricity by the first swing of a galvanometer needle, a correction has usually to be introduced for damping. This correcting factor is simple enough when the damping is small, but becomes more complex as the damping increases, and to facilitate the calculations a table of values of the factor for various values of λ (the logarithmic decrement) had been calculated. From this it appeared that for values of λ less than 0·5, no sensible error would arise from replacing the factor by its first approximation, $1 + \frac{1}{2}\lambda$.

Improvements in the methods of insulating the coils and terminals of galvanometers intended to be used for insulation tests were then discussed. The common plan of allowing the bare wires to lie along the under surface of the ebonite base of the instrument was strongly objected to, and Prof. Ayrton stated that when he was engaged at Messrs. Siemens' works, in 1872, they always had to light a gas jet the first thing in the morning to dry the ebonite base of the galvanometer they were going to use, and thus prevent as far as possible the leakage across the ebonite between the bare wires and the terminals attached to the base. The coils and terminals should always be supported by paraffined ebonite pillars contained within glass cases and kept dry by means of sulphuric acid.

A special form of instrument for high insulation work was exhibited, in which the copper resistance of the coils is nearly 400,000 ohms, and the shortest path along which surface leakage can take place from the coils or from the terminals to the base of the instrument is between 30 and 40in. of ebonite in an atmosphere artificially dried by sulphuric acid. This is attained by supporting the coils from two corrugated ebonite rods, which hang from a brass ring carried on the top of three corrugated pillars fixed to the base plate. The instrument was constructed to drawing by Messrs. Nalder Brothers, but the method of supporting the coils was suggested by Messrs. Eidsforth and Mudford.

With reference to the proportionality of deflection to current in reflecting galvanometers, it was pointed out that ordinary reflecting galvanometers may differ more than one per cent. within the limits of the scale, hence showing the necessity for calibration when any approach to accuracy is desired. Galvanometers of the D'Arsonval type sometimes differ from proportionality more than the one above referred to, but by fitting such instruments with curved pole-pieces, and allowing the coil to hang freely from the top suspension, a proportionality true to less than 0·15 per cent. has been attained over a scale about 30in. long. The following abstract of tests made indicates the amount of error which may arise :—

Ordinary Reflecting Galvanometer.

Deflection	0	...	120	...	240	...	360	...	480	...	600
Corresponding Current...	0	...	121·0	...	242·5	...	363·5	...	483	...	600

Ordinary D'Arsonval Galvanometer.

Deflection	0	...	120	...	240	...	360	...	480	...	600
Corresponding Current...	0	...	118·5	...	240·6	...	359·8	...	473·5	...	600

D'Arsonval Galvanometer with Curved Pole Pieces and Coil hanging freely at the bottom.

Deflection	0	...	120	...	240	...	360	...	480	...	600
Corresponding Current...	0	...	119·9	...	239·9	...	360·2	...	480·7	...	600

Coming to the question of sensitiveness, the importance of keeping the wire as close as possible to the magnets was brought prominently forward, as well as the necessity of reducing the "figure of merit" of various instruments to the same standard in comparing their sensibilities. A satisfactory standard of comparison is, however, not easy to determine. The sensibility in use of any instrument is made up of many factors, some of which arise from the skill of the experimenter himself. It is also desirable to give the data in such a way that the influence of each factor can be separately determined. The authors have therefore endeavoured to distinguish, as far as possible, the three chief factors of the sensibility of reflecting galvanometers, viz., the arrangement and winding of the coils, the construction of the magnetic system, and the optical method of magnifying the angular deflection produced. With the same view the question of the susceptibility of various galvanometers to outside magnetic disturbances has been considered separately, since, first, the electrical qualities of the instrument are not altered by such disturbances; and, secondly, their influence is dependent, not only on the kind of instrument, but on the place of test. Galvanometers have therefore been classified in four divisions, according to their relative sensitiveness to slight variations in the controlling field. The strength of the controlling field is supposed to be so adjusted that the returning moment arising from twisting the suspended parts through a unit angle from the equilibrium position is constant. The four classes, arranged in order of decreasing susceptibility, then comprise: non-astatic galvanometers working in a weak field and with strongly magnetised needles; non-astatic instruments working in a strong field and with needles not so strongly magnetised; astatic galvanometers working in a fairly strong field; and, lastly, galvanometers of the D'Arsonval type working in an extremely strong field.

The optical sensitiveness of a galvanometer is dependent on many considerations which have no connection with the instrument itself.

Digitized by Google

Abstract of Table.

	Type.	Description.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
			r	M	D	S	V	I	D I	S $I^{\frac{1}{2}}$	$D/r^{\frac{1}{2}}$	$D/r^{\frac{3}{2}}$	$S/r^{\frac{1}{2}}$	D $I/r^{\frac{3}{2}}$	S $I^{\frac{1}{2}}/r^{\frac{3}{2}}$	$D/r^{\frac{3}{2}}$ V	$S/r^{\frac{3}{2}}$ V	D $I/r^{\frac{3}{2}}$ V	S $I^{\frac{1}{2}}/r^{\frac{3}{2}}$ V
1	Thomson Single Coil † ...	Tripod Pattern (Finsbury Tech. Coll.)	0·6	3·8	7·6	—	—	—	—	—	10	9·4	5·9	—	—	—	—	—	—
2	,, Double ,, †† ...	Glass Cylinder Pattern (,,)	4,600	1,220	2,440	1,520*	—	—	—	—	53	76	52	—	—	—	—	—	—
3	,, ,, ,, ...	Elliott's Stock Pattern†	7,000	4,300	7,110	4,450*	30	0·013	92	507	85	205	129	2·68	14·7	6 8	4·3	0 089	0·049
4	,, ,, ,, ...	,, Larger Coil Pattern†	12,300	7,680	15,200	9,550*	240	0·013	196	1,090	137	350	220	4·53	25·2	1·46	0·88	0·019	0·10
5	,, ,, ,, ...	,, ,, ,, ...	30,000	10,710	21,800	13,700*	240	0·013	284	1,560	126	353	220	4·6	25·3	1·47	0·88	0·019	0·10
6	.....	Prof. Langley's Bolometer Galv. ...	20	125	250	156*	—	—	—	—	56	76	47	—	—	—	—	—	—
7	Mudford Impd. Single Coil	Foster-Bridge Galv. (Central Inst.).	26	347	349	220*	72	0·035	12	41	68·5	94·4	60	3·26	11·1	1·30	0·82	0·046	0·15
8	,, ,, ,,	Galv. for E.M.F. of cells by Condenser Method (Central Inst.)	2,457	1,375	2,160	1,360*	72	0·035	76	259	43·5	95·5	60	3·34	11·2	1·32	0·83	0·046	0·15
9	,, ,, ,,	Galv. for E.M.F. of cells by Poggendorff's Method (Central Inst.)	6,410	2,720	3,360	2,110*	72	0·035	118	396	42	101	63	3·54	11·8	1·31	0·87	0·049	0·16
10	,, ,, Double ,, ††	Wheatstone's Bridge Galv. (Finsbury Technical College).	700	1,720	2,970	—	—	—	—	—	112	198	136	—	—	—	—	—	—
11	,, ,, ,,	Wheatstone's Bridge Galv. (C. Inst.)	636	1,660	1,600	1,010*	88	0·084	134	293	61	112	74	9·41	21·5	1·25	0·78	0 015	0·23
12	,, ,, ,,	Variable Damping Galv. (Cen. Inst.)	9,744	4,200	4,280	2,640	200	0·052	222	615	43·5	108	67	5·61	15·3	0·54	0·34	0·028	0·78
13	,, ,, ,, ‖	High Resistance Galv. (Cent. Inst.)	360,000	50,000	54,200	34,000*	236	0·01	542	3,400	90	324	202	3·24	20·2	1·37	0·85	0·014	0·086
14	Rayleigh, Gray) Two coils	Rosenthal Micro-Galv. (C.I.) Non-ast.	44	22·9	25·4	16	0·29	1·5	38	31	3·82	5·6	3·5	8·40	4·3	19 0	9·2	28·5	14·8
15	,, ,, ,, ‖ or Rosenthal)	Astatic.	44	25	27·7	17·4	0·29	0·70	19·4	23	4 2	6·1	3·8	4·27	3·2	21	10·3	14·7	11·0
16	,, ,, ,,	Profs. T. and A. Gray's Instrument	30,000	32	64	40*	51	50	3,200	283	0·37	1·04	0·6	5·2	4·6	0·02	0·013	0·10	0·09
17	,, ,, ,,	Ballistic Galvanometer (Cent. Inst.)	4,090	54	63	39·2	36	17	1,070	165	1·0	2·36	1·4	40	6·1	0·07	0·04	1·1	0·17
18	Deprez D'Arsonval	Carpentier's Ord. Make (Crompton's).	208	286	375	236*	—	—	—	—	26	41·3	27·9	—	—	—	—	—	—
19	,, ,, ...	Jolin's Make, Low Resistance (C.I.).	3·8	39	42	2·64*	0·60	5·5	230	62	21·5	25	15·5	13·4	36	41	26	225 4	61
20	,, Invariable	Sensibility Home-made (Central Institution) ...	21	190	181	114*	0·96	13	2,360	410	39·4	54	33·6	700	132	56	35	730	126

EXPLANATION OF TABLE.

r = resistance in ohms.
M = millimetres deflection per micro-ampere when the period is 10 seconds and the scale is placed as in the actual use of the instrument.
S = swing produced per microcoulomb under the same conditions as for D.
D = deflection in divisions per micro-ampere when the period is 10 seconds and the scale distance is equal to 2,000 scale divisions.
I = moment of inertia of suspended parts in C.G.S. units (only approximate).
V = volume in cubic centimetres occupied by the convolutions of wire (only approximate).
* These numbers are calculated from the corresponding values of D.
† The constants of these instruments were kindly supplied by the makers.
‡ These instruments were tested after being in use for some years, the needles not being re-magnetised.
‖ Large.

Thus the goodness of the mirror, the distance of the scale, &c., are important factors. The authors have hence contented themselves with giving the number of scale divisions per micro-ampere or per micro-coulomb, assuming the scale to be placed at a distance from the mirror equal to 2,000 scale divisions. As the scale distance most generally used is a metre, and as the scale divisions are frequently in half-millimetres, the conditions assumed are often fulfilled in practice. The sensibilities for a steady current, and for a discharge are thus directly expressed in angular measure, irrespective of optical magnification. The sensibility at the usual scale distance employed with each instrument is, however, given as a guide, for it must be remembered, in comparing sensibilities for the same periodic time of vibration, that two instruments may have very different sensibilities, although identical in all respects save the moment of inertia of the suspended parts, and these may differ because a larger and heavier mirror has been attached in order to employ a longer scale distance.

An important and difficult question is whether the factor of merit of a galvanometer should be given under the condition of constant period, or of constant controlling moment, or of constant controlling field. The first is the easiest to obtain and to calculate from, and is most readily understood. In the table of data of the many instruments tested, only an abstract of which is here published, two columns have therefore been reserved for the values of D and S, which respectively denote the deflection per micro-ampere and the swing per micro-coulomb, each in scale divisions, when the period is 10 seconds and the scale distance is 2,000 scale divisions. The corresponding values at any other period T are of course $DT^2/100$ and $ST/10$. It is, however, unfair to judge the relative merit of two instruments by simply comparing their action when the period is 10 seconds in each case, for this period may be unsuitable for use with one or both of them. It is, moreover, not quite right to compare the values of D and S when the usual periods are employed, as these may not be all equally favourable to the instruments considered. The authors therefore determined to reduce the numbers to their corresponding values under the condition of constant controlling moment per unit angle. The alternative of constant controlling field was rejected because it is inapplicable to instruments of the D'Arsonval type. The stability of the zero of any instrument, however, depends on the controlling moment per unit angle, and the values of D and S (*see* Table) have therefore been multiplied respectively by I and $\sqrt{I}$ where I is the moment of inertia of the suspended parts in C.-G.-S. units. In this manner the numbers contained in columns 7 and 8, proportional to the sensibilities for constant controlling moment, have been obtained, and these, perhaps, give a fair comparison between the various instruments when the time required to take an observation is entirely unimportant. It should be borne in mind, however, that the period of instruments in which the moments of inertia of the suspended parts are large, such as Rosenthal, Gray, or ordinary D'Arsonval galvanometers, would be inconveniently long.

The influence of resistance has next to be considered. If two galvanometers differ only in the gauges of wire with which they are wound, and the convolutions are similarly distributed, then the sensibilities should be proportional to the number of turns. If, again, the thickness of the insulating covering bears a constant proportion to that of the wire, then the resistance of the coils would be proportional to the square of the number of turns, so that the values of $D/r^{\frac{1}{2}}$, $S/r^{\frac{1}{2}}$ would be constants for the same pattern of instrument, where D and S are the number of scale divisions per micro-ampere and micro-coulomb respectively, and r is the resistance of the galvanometer. The proportion in question, however, varies not only for coils of different resistances, but also in the same coil, for several different gauges are generally used in winding the various portions. To get some idea of the relation between resistance and sensibility the authors have made tests on galvanometers of the same pattern but of different resistances (the same magnetic system being used throughout), and have found that D and S vary approximately with the value of r raised to the power 2/5, *i.e.*, $D/r^{\frac{2}{5}}$ and $S/r^{\frac{2}{5}}$ are approximately constants for galvanometers of the same pattern. These quantities have, accordingly, been taken as the factors of merit of the galvanometers for constant period, and their values are given in the table (*see* cols. 10 and 11).

Another question to be considered is the factor of merit in connection with the volume of the coils. As this is important as regards the cost of high-resistance galvanometers, a separate column (5) is therefore given, showing the approximate volume in cubic centimetres occupied by the wire in each instrument, and other columns (14, 15, 16, 17) give the values obtained by dividing this quantity into the various factors of merit. The results of comparison in these latter columns are very interesting. It appears that galvanometers of the Rosenthal or Gray and the D'Arsonval types are by far the most sensitive in proportion to the volume of coil. The authors believe that the best way to make a very sensitive galvanometer with a movable magnetic system is to employ several small coils, instead of one or two large ones, and that the magnets should be horseshoe shaped, with the line joining the poles vertical, as in Professor Gray's

Digitized by Google

instrument, but modified so as to give a smaller moment of inertia.* Such a magnetic system can be made very delicately astatic, and the weakening of the magnets with time does not greatly influence the astaticism. The authors also conclude from their investigations that the most sensitive galvanometer of all would be one of the D'Arsonval type suitably modified. The poles of the magnet should be very close together, the coil should be very small, and no stationary iron core should be used inside the coil, as in the ordinary D'Arsonval galvanometer. The sensitiveness could be further increased by employing electro-magnets instead of permanent ones to produce the deflecting field.

Experiments have also been made on the co-efficients of self-induction of galvanometer coils, and a table of values is given in the Paper. From this it appears that a coil of ordinary size used in Thomson galvanometers has a co-efficient approximately equal, numerically, to one-thousandth of its resistance in ohms. If the coils of the instrument are in series and placed near each other, as in actual use, the co-efficient is increased by about half its former amount, owing to mutual induction; so that for Thomson galvanometers whose resistances vary between 1,000 and 10,000 ohms, the time constant is about 0·0015 second. Very high resistance instruments have a smaller time constant owing to the increasing importance of the insulating covering of the wires. The authors also discuss the possibility of judging the electrical qualities of galvanometer coils by measurements of their induction co-efficients.

The importance of having the magnets of galvanometers as strongly magnetised as possible is illustrated in a table showing the results of experiments made at the Central Institution. In many cases the sensibility of an instrument has been trebled (for the same periodic time of vibration) by simply re-magnetising the needles, and in one case the sensibility of an instrument had fallen to one-fifth of its original value by the weakening of the magnets with time and use. The experiments show that however carefully a galvanometer may be used, it is advisable to re-magnetise the magnets occasionally.

In view of Mr. Preece's remarks at the Institution of Electrical Engineers on January 23rd, on the deteriorating quality of magnet steel, it is of the first importance that for sensitive galvanometer needles only the very best quality obtainable should be employed.

Owing to the lateness of the hour the discussion on the Paper was postponed to the next meeting, which is to be held to-day (Friday).

THE ARON METER.

So far as we are aware, no independent report has, up to the present, been published in this country as to the degree of accuracy which any of the numerous types of electricity meters now coming into use may be expected to attain under conditions approximating those likely to obtain in practice. The following report of Mr. Gisbert Kapp to the General Electric Company, on the well-known Aron Meter (see *The Electrician*, February 8, 1889, p. 393), will therefore be of interest both to consumers and to the various electric supply companies:—

GENTLEMEN: I have subjected the Aron Meter which you supplied to a series of tests, extending over about 10 days, and now report to you on the results of these tests.

The meter consists of a pair of pendulum clocks, so geared together as to register the difference in their rates on a set of dials. One of the clocks has an ordinary pendulum, whilst the bob of the pendulum of the other clock consists of a fine wire solenoid, placed horizontally, and swinging within a fixed solenoid of much stouter wire, through which passes the supply current which is to be metered. The fine wire solenoid is connected in series with a resistance coil, and the two form a shunt to the supply leads. The connections are so arranged that there is attraction between the shunt solenoid and the main solenoid, and consequently acceleration of the electric as compared with the gravity pendulum: the difference in rate, which is registered on the dials, being very nearly proportional to the amount of energy passed through the meter in any given time. To find this energy, we have, therefore, to multiply the number registered on the dials by a coefficient, which must be determined for each meter by experiment, and which in an absolutely perfect meter should be a constant for all currents and pressures within the range of this instrument. I do not know any meter in which the coefficient is absolutely constant: it varies with the amount of current, and the amount of variation is an indication of the greater or less accuracy of the meter. To judge of the merits of a meter it is only necessary to determine the co-efficient for different currents and pressures, and to compare the coefficients with each other. The more nearly the coefficients agree, the greater is the degree of accuracy attained by the meter.

I have tested your Aron Meter at pressures varying between 130 and 95 volts, and with currents varying between 26 and 7 amperes, both direct and alternating. In addition, I have also made a prolonged test with a direct current of 0·65 ampere.

The meter is designed for a mean pressure of 100 volts, and a maximum current of 25 amperes. I found that the coefficient is practically unaffected by variations in pressure between the limits of 95 and 130 volts. The pressure was measured by a Cardew voltmeter, and by a Sir William Thomson electrostatic voltmeter. I calibrated the Cardew voltmeter by means of a Clark standard cell, and its indications agreed perfectly with Sir William Thomson's instrument. The currents between 7 and 26 amperes were measured by a Sir William Thomson ampere balance, and the current of 0·65 ampere was measured by a Sir William Thomson deci-ampere balance. With the larger currents the readings were taken every quarter of an hour, and with the smaller currents they were taken at longer intervals. In this case the current was taken through a single lamp from a secondary battery ordinarily supplying 40 lamps, and was therefore absolutely constant over a period of many hours, rendering it unnecessary to take frequent readings. The tests at high voltage (from 110 to 130 volts) were made whilst charging the secondary battery, and those at normal voltage (from 95 to 105 volts) were made whilst supplying the lamps from the battery when the current was direct, and whilst supplying the lamps from a transformer when the current was alternating. The conditions of the tests were therefore those which obtain in the actual use of meters.

The coefficient given by Dr. Aron for this meter is 1·07; that is to say, at about 100 volts pressure between the mains one division on the uppermost dial represents 107 watt hours. I first tested the meter in exactly the condition in which it came to me, and found that for currents varying between 25 and 15 amperes the coefficient given by the maker was nearly correct. For smaller currents the coefficient was, however, incorrect, and the error increased as the current was diminished. Thus, with current required for one single lamp, my test gave a coefficient of only 0·97. I found that this discrepancy was due to the fact that the meter had not been properly regulated before it was sent to me. In order that a clock-meter of this kind may register accurately it is necessary that the gravity pendulum should have exactly the same period as the electric pendulum when no current is passing. In this meter the gravity pendulum had a longer period, and consequently the meter registered, even when no current is passing. This defect can very easily be rectified, since the gravity pendulum is provided with a weight which can be screwed up or down as may be required in order to bring the two pendulums to absolute synchronism. I found it very easy to make this regulation, and my subsequent tests were made with the meter so regulated. I mention this matter to draw your attention to the necessity of regulating every meter after it is installed.

Test of Meter with Direct Currents.—The meter being intended for a 40-light installation, it seemed advisable to test it within the limits of current which would ordinarily obtain in such an installation. I made, therefore, prolonged tests with currents of 8 and 23 amperes, which corresponded to 12 and 35 lamps respectively. The coefficients I obtained were the following:—With 35 lamps, 1·30; with 12 lamps, 1·141. I also made a prolonged test with a single lamp, in order to determine the accuracy of the meter at the lowest current at which it can possibly be used in practice. This test is for all meters the most severe, since any error, however small absolutely, becomes relatively large if the current to be metered is very small. I found that, even at the lowest limit of current, the Aron Meter gave a remarkably accurate result, the coefficient being, with one lamp, 1·146. On the basis of these figures it is now possible to form an estimate of the accuracy of the meter when in practical use. Taking the mean between the coefficients for 12 and 35 lamps, I find 1·1355 as the coefficient to be used with this meter. The maximum error which would obtain if the meter were always worked at the lower, or always at the higher limit of current, would then be one-half per cent.; but as in practice the meter will generally be worked at intermediate currents the probable error will be less than one-half per cent. I need hardly say that this degree of accuracy is greater than that of any gas meter, and more than sufficient for all practical purposes.

Test of Meter with Alternating Currents.—As there must necessarily be some self-induction in the fine wire coil forming the bob of the electric pendulum, the shunt current must lag behind the main current, and the acceleration will be somewhat less than with a direct current representing the same energy. It will also be evident that the difference will be the greater the higher the frequency of the alternating current, so that the coefficient of the meter, as found by experiment with direct currents, will not be applicable if the meter is to be used with alternating currents, and a new coefficient must be experimentally determined for every

* Mr. C. V. Boys, F.R.S., in his Cantor Lectures on "Instruments for Measuring Radiant Heat" (April, 1889), has also shown that galvanometers with small coils may be made very sensitive (pp. 22, 23).

Digitized by Google

frequency. I have accordingly tested the meter at two frequencies, which may be considered limiting values for practical work, viz.: 105 cycles per second (or 12,600 reversals per minute). As regards current strength, I have in both cases made the tests within the same limits as those I adopted for the direct currents, and I give the results in the following table:—

Number of Lamps supplied.	Coefficient for a frequency of 105	70
35	1·95	1·170
12	1·220	1·194

Taking, as before, the averages between these figures, I find that the coefficient to be used with this meter is—

1·207 for a frequency of 105, and
1·182 for a frequency of 70.

In either case the maximum possible error is 1¼ per cent, whilst the probable average error will be considerably smaller than 1¼ per cent. This degree of accuracy, though not so great as that found with direct currents, is still quite sufficient for all practical purposes.

The energy absorbed in the meter varies with the current passing through it. At a pressure of 100 volts the energy absorbed is—

With 1 lamp ..... 3 watts.
With 12 lamps ..... 4 watts.
With 35 lamps ..... 9 watts.

My experiments lead me to conclude that the accuracy, long range, and economy of power shown by the Aron Meter make it a very satisfactory instrument, both for direct and alternating currents.

Yours faithfully, GISBERT KAPP.

THE METROPOLITAN BUILDING ACT.

We are indebted to Mr. Crompton for the following copy of Mr. Slater's letter on the subject of the Metropolitan Building Act, and its bearing upon the construction of central stations, which was referred to at the last meeting of the Electrical Trades Committee.

Copy.

January 21, 1890.

DEAR CROMPTON: In answer to your inquiry as to the points in connection with the Building Act which operate most oppressively with the new electric lighting central stations, I may mention:

1. Size. The limitation of a building strictly to 216,000 cubic feet may prove a most awkward restriction, and I understand that the London Electric Supply Corporation have a clause inserted in their Act to the effect that the limitation should not apply to them. What in my opinion should be done is that a clause should be inserted in the Building Act to the effect that if any one wishes to build a factory of a larger size than that stipulated, the County Council should have power to sanction it upon being satisfied with the method of construction, if it is in their power to sanction it at all.

2. It frequently happens, as was the case at Knightsbridge, that part only of a station is built at first, and a wall of a temporary character is required, but although this wall may adjoin no other property, it must be built in all respects, as to thickness, openings, &c., in accordance with the Act, as if it adjoined a thoroughfare.

3. A small workshed or office cannot now be erected on a site unless it is enclosed with brick walls (preventing very useful galvanised iron buildings) without the special sanction of the Council. I think the district Surveyor ought to have the power to sanction such a building, upon satisfying himself that it will not cause risk to other buildings.

4. Buildings of the warehouse class are compelled to have their roofs of a certain pitch which is very low, and thus it would be impossible to build a mansard roof containing living rooms or offices over an electric lighting station. This seems to me a perfectly useless and harrowing restriction, and I cannot imagine why it is insisted upon. My recent consideration of the Building Act and Amendment has forced me to the conclusion that a strong consolidating Act for the whole of London, controlling building operations, and preventing the disgraceful jerry building that goes on in all quarters of the metropolis is urgently needed, and if your Chamber of Commerce could urge this it would be doing a very good work. The present work barely touches the speculating builder, but harasses at all points the man who wants some new arrangements. [Signed] J. SLATER.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *January* 25, 1890.

The Establishment of Electric Light Associations.—The movement set on foot some months ago for the establishment of electric light associations in various States is already assuming encouraging proportions, and promises to have important results. Some seven or eight States have already fallen into line, and among them may be mentioned Massachusetts, Maine, Connecticut, New Hampshire, Rhode Island, Maryland, Michigan, and Illinois. This week New York participated in the movement, and steps for the formation of a New York association were taken at Albany. Before many months have gone by it is likely that most of the States of any size or population will have given in their adherence to the plan. In New York, more perhaps than anywhere else, this movement for the protection of established interests has been found necessary. As I wrote you in my last letter, it is already proposed to extend throughout the State the supervision now exercised by a Board in this city, so that all the electrical companies of the State will be subject to control and official direction, very much in the same way as the railroads are. It is evident that the operation of such a commission must be carefully watched, and, if necessary, met with opposition, or, when in the line of growth, its good work assisted to the fullest extent possible. By the time the annual meeting of the National Electric Light Association is held at Kansas City, the movement above indicated will have grown to such a size and taken such definite shape that I have no doubt that it will be found necessary and expedient to bring the national body into some kind of affiliation with these State organisations.

Agitation for the Repeal of the Copper Duty.—Another matter of general interest to electrical communities that is being agitated at the present time is the repeal of the duty on copper. A petition was presented last week to the Committee on Ways and Means of the National House of Representatives asking that action be taken for the abolition of the duty on copper ingot, plate, bars, rod, and wire. An address was made by Mr. George M. Phelps in presenting the petition, in which he stated that the electrical lighting industries interested represented a capital of no less than $275,000,000, and has already established some 238,000 arc lights and 2,700,000 incandescents. It was estimated that in the total cost of electric plant for light and power work, the outlay for copper was from one-quarter to one-third of the whole, and hence the copper duty was a serious tax upon the industry. At the same time the duty seemed to be wholly superfluous as a protection to American producers of that metal, for the United States not only exported the metal, but possesses the finest copper mines in the world. The result of the tariff, therefore, was simply to enable mining companies and dealers in copper to establish and maintain excessive prices through combination for that purpose. In view of these facts, therefore, and seeing that the duty on copper was at once useless for revenue and unnecessary for production, the Association, Mr. Phelps said, was of the opinion that the copper tariff should no longer remain in existence, it being the duty of the Government not to lend its assistance to any process by means of which combinations for maintaining the prices of the raw material artificially could be assisted to success. Of course, this line of argument is narrowed down strictly to copper, and, so far, has the support of almost everyone connected with electrical pursuits, it being impossible to blind oneself to the bad effects of the high price of copper on the development of electrical industries. It is evident, however, that such an argument has a somewhat wider scope and sweep, and could well be made to apply to other materials that are equally needed for the perfect industrial development of the resources of the country.

American Opinions on the Deptford Station.—There is quite a little interest, I may almost say anxiety, felt in this country amongst a great many electrical engineers as to the long delay in starting the huge Ferranti station at Deptford. A great many of us have been waiting from week to week for

Digitized by Google

its going into operation, and it is no exaggeration to say that its success would be the means of stimulating not a little work in this country along the same lines. But the continued delay has proved somewhat disheartening to the advocates of extreme high tension on the Ferranti plan, and at the present time not a few rumours and reports are current in this city as to the reasons why the station does not start up. Some of the reports go so far as to say that Mr. Ferranti is not only making material changes in his machine, but in his novel form of circuit, and also intends to operate for some time to come at a lower voltage than 10,000. Speaking of voltage reminds me that the fact has recently been elicited in this country that in Detroit some of the Brush circuits there have even been run as high as 9,000 volts by coupling up in tandem two or three of the regular series arc light circuits. I do not know whether this practice has to any extent been followed elsewhere, although it is understood that some few months ago, when so many of the circuits in New York were cut down, some of the remaining circuits were connected together and run at a very high figure in order to give the necessary service. There has been mention once or twice lately of large new arc light machines which would run up to 4,500 to 5,000 volts; and I have heard it said that one of these machines, as if by irony, is to be installed at Orange, where Mr. Edison lives. It is hoped that where these high voltages are adopted the line construction and insulation will be as good as they can be made; and after all, perhaps, when all the proper pains and precautions have been taken, there is no great difference between 2,000 and 5,000. But we shall probably wait to learn a little more from England about Mr. Ferranti's 10,000 volts of alternating current before we make any very serious efforts in that line ourselves. I need hardly say that in a country like this, where so much is put on a single throw of the dice, and where one of the predominant characteristics of business life is an absence of caution and an excess of daring, there has been no little admiration of Mr. Ferranti's pluck; but evidently this is one of the cases where a man must be judged by the results. On one point at least the opinion of American engineers has for some time been practically unanimous, and that is that Mr. Ferranti made a serious mistake in proposing to concentrate all his generating capacity for so many hundreds of thousands of lights in one station. We are likely to see in this country larger stations than any we have yet had; but in no cases in the large cities will there be an endeavour to put all the eggs in one basket. We shall see a continuance of the plan of dividing up the capacity in a number of stations, and then, as far as possible, connecting up into one whole the different networks of distribution proper to each station, thus reducing to a minimum the possibility of any cessation of supply in any one district.

Development of the Westinghouse Company.—It may be interesting to note that, owing to the recent great growth in its business, the Westinghouse Electric Company proposes to move its works out from Pittsburgh, and to establish large new factories a short distance from that city. It contemplates the development, in short, of a new industrial community, which will be devoted exclusively to electrical work, just as Pulman, for instance, is devoted to car building. As far as I am aware, this will be the first electrical enterprise that has thus given birth to and maintained a town by itself. At the present time the Westinghouse Electrical Works are said to employ 1,000 to 1,200 hands, and it is claimed that in a short time the electrical enterprises thus gathered together in their new home will employ no less than 4,000 to 5,000. There can be no question as to the enormous activity of the Company at the present time—an activity which seems likely to be maintained, and even increased, with the development of various new electrical inventions and enterprises. The Company is reported to be very busy just now getting ready for an extensive exploitation of its new alternating current arc light system, and it is also busy with its Tesla motor, of which an interesting and entirely successful application has just been made in mining work. It is understood that the Company will soon be ready to enter the electric railway field, and to make a bid for the business that there awaits attention.

Electric Traction at Boston.—The reports that I receive from Boston lead me to believe that, if all goes well, it will not be long before that city has an overhead electric railway in its narrower and more tortuous streets. It is said that the plans of the system are all made, though not yet open to general inspection, and that the structure and methods are a very great improvement over what has been previously done in that direction. The Thomson Houston Company, of course, has the work in hand, the enterprise being that of the West End Street Railway Company, which has already pushed the electric railway system so extensively and thoroughly in the more outlying parts of the city and in the suburbs.

BRUSSELS NOTES.

(FROM OUR OWN CORRESPONDENT.)

BRUSSELS, *February* 1, 1890.

The question of the electric lighting of Brussels, over which so much ill-feeling has been aroused owing to what is considered to be the undue preference shown to the Germans by the Conseil Communal, was somewhat hotly discussed at a recent meeting of the Société des Ingénieurs Industriels. M. Van Rysselberghe was the first speaker, and after holding forth against the German interlopers, proceeded to give some figures relating to his hydro-electric scheme, to which I have referred in previous letters. The Belgians are ready, said M. Van Rysselberghe, to supply current at 3·5 centimes per lamp-hour, and to hand over 10 per cent. of the gross receipts to the Caisse Communale. The Germans, on the other hand, propose to charge 5 centimes. In M. Van Rysselberghe's opinion, the electric current cannot be transmitted economically to great distances, since it is burdened with the law of Joule. According to the speaker, the cost of the hydro-electric scheme would be less than one-sixth of that of a three-wire installation. M. Van Rysselberghe was followed by M. Bède, who alluded somewhat warmly to the *chauvinist* attitude taken up by the Belgian electrical firms with regard to the tender of the German company. M. Bède asserted that the multiplicity of small dynamos involved by the hydro-electric scheme was a very wasteful feature, nor was he enamoured of the idea of running 35mm. pipes containing water at 50 atmospheres pressure under the streets of Brussels. With regard to the comparative cost of the two systems, M. Bède thought the figures cited by M. Van Rysselberghe would prove in practice to be very fallacious. Finally, M. Bède stated that the hydro-electric idea had been tried in Germany, and had proved a complete failure. Meanwhile the Commission d'Electricité has resolved to recommend the Conseil Communal to accept the proposals of the Société Internationale d'Électricité (Liége), of the Allgemeine Gesellschaft (Berlin), and of M. Van Rysselberghe, the district to be allotted to the German firm being the centre of the town. The feeling in favour of the electric light has, I may add, considerably cooled of late, owing to one or two ugly failures, due chiefly to bad workmanship, the result of the price-cutting mania which at present afflicts Belgian electrical contractors.

CORRESPONDENCE.

TRAINING FOR THE ELECTRICAL INDUSTRY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I was so pleased with your leading article on this subject in *The Electrician* of last week that I read it to my laboratory students. The sentiments expressed in your article are almost identical with those I have been instilling into the minds of the many young men who come here fancying that they will find some "short circuit" or "bye-path" into the profession of electrical engineers. Of the many sorts and conditions who attend our classes expecting to be "transformed" in a single term into electricians or electrical engineers, none tackle to their work more earnestly or pick up the elements of testing more rapidly than those who have served a complete apprenticeship to mechanical engineering. To the boy fresh from school who hopes to become an electrical engineer by simply attending a session of our lecture and laboratory courses, we point out the training which we ourselves went through, viz., two years at pattern-making, two at turning metals, two at finishing and erecting steam engines and boilers, some months at moulding, two years in the drawing office, and three sessions at the University Science Classes, before being fit to

Digitized by Google

act as an assistant in the manufacture and laying of submarine cables!

You say, "Nearly all large engineering firms derive a considerable income from premiums paid by the sons of wealthy parents. . . . Those boys who enter without premiums as bound apprentices have such long hours of labour, and so few chances of acquiring an all-round knowledge, that few of them can hope to become fully-trained . . . "

Such views do not agree with the state of matters on the Clyde, for here very few firms will take a premium, or even a bound apprentice. The lad, whoever he is, works for what he is worth, and he can have here in the evenings a complete training in mathematics, natural philosophy, engineering, drawing of all kinds, chemical and electrical engineering, lectures and laboratory work, as well as experiments with, and descriptions of, machines and steam engines. If the apprentice goes to his work by 6 a.m., and gets free therefrom by 5 p.m., what is to hinder him from attending such classes regularly twice a week from 7:30 to 9:30 p.m., and to study at home for two hours on at least two other evenings per week? If such a course should be too hard for him (we have over 1,000 students doing it in full at present), then he can attend our day classes and laboratories for the same subjects, and take things more leisurely. There is one thing certain: we cannot turn out from a technical college a full-blown electrical engineer, but we can and have often produced very competent electricians who were either content to remain electricians, or who went and picked up the necessary mechanical and commercial knowledge in a manufactory. Some of the largest and best firms have applied here direct for competent electricians—men capable of taking charge; and having got them, seem perfectly satisfied with their abilities and knowledge, whilst others applied for mere apprentices.—Yours, &c.

ANDREW JAMIESON, Prof. of Engineering.

The Glasgow and West of Scotland Technical College Electrical Engineering Laboratory,
Feb. 4th, 1890.

OVERHEAD WIRES AND THE ELECTRIC LIGHT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I cannot understand the prejudice of the public to overhead wires, and in your article of last week's edition upon this subject you mentioned "that there are ways of doing overhead work, however, that would be inoffensive, inexpensive, and safe." I am firmly of the same opinion, and that if such an appliance as an indiarubber compensator, as I mentioned in my article to *The Electrician*, January 6, 1888, were used, there would be no danger from the breaking of overhead wires, and, save for a small area, the breaking up of roads and laying costly mains. Therefore, I think if these compensators were used they would, in the case of overhead electric light wires, meet with the requirements of the Board of Trade.—Yours, &c., R. S. BOZON.

12, Robert-street, Brighton, February 5, 1890.

DOUBLE BREAK SWITCHES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Noticing in your issue of last week that you describe and illustrate a double break switch by Messrs. Woodhouse and Rawson as *new*, I would draw your attention to those made by my firm and patented December, 1888. These switches were shown at the Building Trades Exhibition in August last, and again at Bingley Hall, Birmingham, and illustrated in the Exhibition Number of *Electrical Plant*. They have also been illustrated in one of my firm's switch catalogues during the whole of last year.

I have pleasure in sending you blocks of Simple Double Pole Switches, also one illustrating a six-way switch working on the same principle.—Yours &c., ARTHUR C. COCKBURN.

London, February 5, 1890.

[We hope shortly to publish a brief description of these switches.—ED. *E.*]

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning.*]

"The Electrician" Electrical Trades' Directory and Handbook for 1890.

We have pleasure in announcing that the new edition of our Directory and Handbook is now ready, and orders already in hand will be executed to-morrow and Monday. The book consists of 850 pages, and has entailed this year an exceptionally heavy amount of work. We believe the book will be found very accurate, much care having been taken to make it so. There are several features of great present interest to the Electrical Trades in the Literary Section of the book, notably a Digest of the Law relating to Electric Lighting. Much attention has been devoted to compiling a reliable list of County Council, Borough Council, and other Local Authorities' officials throughout the United Kingdom; and every effort has been made to render the book useful. The Colonial and Foreign Division will be found extensive and reliable. Orders should be forwarded at once.

TENDERS INVITED.—The guardians of the Hackney Union invite tenders for supplying and fixing a dynamo, cables, wires, lamps, fittings, &c., for lighting the workhouse extension, infirmary, pavilion, board room, and office at Homerton, London, E. Firms tendering will obtain all particulars from Mr. Walter Barnett, surveyor, Winchester House, Old Broad-street, E.C. Tenders must be delivered to Mr. J. Owen Perry, clerk to the Union, by 1:45, p.m., on Wednesday next, the 12th inst.

——— The Town Council and Borough of Barnsley invite proposals for the supply of the electric light for public and private purposes. All information and forms can be obtained of Mr. J. Henry Taylor, C.E., Borough Surveyor, Barnsley, and proposals must be delivered to Mr. Henry Horsefield, Town Clerk, Church-street, Barnsley, by 10 a.m. on Friday, the 28th inst. Further particulars of the above will be found on page xv. of our advertisements.

LONDON COUNTY COUNCIL.—We learn that the Standing Committee of the London County Council are prepared to unanimously recommend Mr. Binney, of Bradford, for the office of chief engineer to the Council, rendered vacant by the resignation of Mr. Dunscombe through ill-health. It will be remembered that Mr. Dunscombe recently succeeded the late Mr. Gordon.

ELECTRIC MOTORS FOR WORKING TELEGRAPH INSTRUMENTS.—We learn that Messrs. Shippey Brothers (Limited) have recently supplied the Column Printing Company with one of their new type ⅛ horse-power standing motors, wound for 13½ volts. It is driven by a 9 volt C C battery with lifting arrangements, in order to regulate the speed of the motor. The cylinder is fitted with Prof. Wheeler's automatic regulator, which varies the speed according to the requirements of the work done. The motor is, we understand, giving every satisfaction.

MESSRS. ALLPRESS AND BELSHAW.—This firm have removed from 49, Victoria-street, and have taken more commodious premises at 55, Victoria-street, London, S.W.

DISSOLUTION OF PARTNERSHIP.—Messrs. Chappell and Co., of Heathfield, near Bovey Tracy, electric carbon manufacturers, have dissolved partnership.

NATIONAL TELEPHONE COMPANY'S SCOTTISH DIRECTORY.—We have received the new edition of this Directory, which bears evidence of considerable increase in the number of subscribers over that issued for 1889. It is very neatly got up, and contains the name of every exchange subscriber in Scotland and Cumberland.

PERSONAL.—The inspectors and over fifty workmen of the Liverpool Electric Supply Company dined together at the Falcon Day Hotel, Lord-street, on the 31st inst., and presented a marble timepiece to the retiring chief inspector, Mr. A. Lester Taylor, who has recently gone into business at 40, Burdett-street, St. Michael's, Liverpool.

THE AGRICULTURAL ENGINEERS' ASSOCIATION.—Mr. Cooper Corbidge, F.C.A., of the firm of Camm, Corbidge, and Co., has been appointed secretary of this association.

The Telephone in Russia.—The St. Petersburg correspondent of *The Times* reports that successful telephonic experiments have just been carried out between St. Petersburg and Moscow, a distance of nearly 500 miles, over the ordinary telegraph wires.

Digitized by Google

LEGAL INTELLIGENCE.

International Cable Company (Limited).

The petition presented by A. S. Bolton for the winding up of this company was again before Mr. Justice Stirling, in the Chancery Divison of the High Court of Justice, on Saturday last.

Mr. HASTINGS, Q.C. (with him Mr. Grosvenor Woods), asked that the petition might stand over, with liberty to cross-examine the deponents upon their affidavits. He said the company was formed to lay a cable under a Portuguese concession, and the petitioner alleged that the concession had been forfeited. This was denied on behalf of the company, and therefore he wished to cross-examine the persons who so stated.

Mr. BUCKLEY, Q.C. (with him Mr. J. Chester), on behalf of the company objected to any adjournment, alleging that the petition was a demurrable one. The petitioner, when sued for his calls, by way of retaliation presented the winding-up petition.

Mr. HASTINGS said the petitioner was a man of large means, and perfectly able to pay his calls.

His LORDSHIP said he would deal with the question of demurrer at once.

Mr. HASTINGS then read the petition, from which it appeared that the company was incorporated, with a capital of £1,000,000 in £10 shares, to lay cables between the Azores, West India, Canada, the United States, and Great Britain; that within the last few months the concession from the Portuguese Government had lapsed, and that no renewal could ever be obtained. It was further alleged that moneys had been improperly paid to the promoters, that the directors had gone to allotment without sufficient shares being subscribed for, that the company had not commenced business within a year of its incorporation, and that, in fact, the substratum of the company had entirely gone. The learned counsel said there was a distinct allegation that the object of the company was the connection of Portugal with the Azores and the continent of America, which could only be done under a concession from the Portuguese Government, and that this concession was gone, and, therefore, upon the authorities there was an entire loss of the substratum of the company, which justified the petitioner in asking the court for a winding-up order. In support of this proposition he cited the cases of the Haven Gold Mining Company and the German Date Coffee Company.

Mr. BUCKLEY said the allegation that the company had not sufficient capital was not enough to obtain a winding-up order. No doubt the petitioner was disappointed in not having received orders for copper wire which he would have set off against his calls, but that was no reason for winding up a company which was carrying on the business for which it was incorporated. The petitioner was not supported by a single shareholder. He suggested that this was not a *bona fide* petition, but was presented with an ulterior purpose.

His LORDSHIP having expressed an opinion that the petition was not demurrable,

Mr. BUCKLEY said he would not press his objection further.

Mr. WARRINGTON said he appeared for shareholders representing £34,000, and he supported the petition.

Counsel for shareholders holding 1,100 shares and creditors to the amount of £700 said he was instructed to oppose the petition.

His LORDSHIP ordered the petition to stand over until after the cross examination was completed.

Hinds v. Smith—Christopher v. Same.

These were appeals before Mr. Justice Denman and Mr. Justice Wills, against orders by Mr. Baron Pollock dismissing or staying various actions against the Right Hon. W. H. Smith, Sir John Hawkshaw, Sir Joseph Whitworth, Lord Alfred Paget, and others, Directors of the Old Electric and International Telegraph Company, incorporated by special Act in 1846. The statement of claim in each case was alleged to be the same, with the exception of the names. The statement was a long and complicated document, from which it was difficult to gather any cause of action. The plaintiff Hinds, who appeared in person, was said in the statement of claim to be the surviving partner of the late Thomas Allan, of Edinburgh, electrician. The claim stated that T. Allan came to London in 1849 and became the pioneer of electric telegraphy and light, submarine ropes, &c., and spent much money in this pursuit; that in 1851 a local Act, 13 and 14 Vict., cap. 137, granted to him the right to work a patent in the name of the United Telegraph Company. The claim stated that the profits of the Electric and International Company through working a concession granted to Allan in 1852, and up to January, 1870, the date of the transfer of the telegraphic undertakings to the State, amounted to about £1,000,000.

The Court read the statement of claim through, and came to the conclusion that it was frivolous and vexatious, and accordingly dismissed the appeals.

Mr. HINDS claimed a right to read the statement of claim through, and referred to section 24 of the Judicature Act, 1873. He became abusive to the Court, and was repeatedly ordered to be quiet. This order he disobeyed, and the usher was directed to remove him.

Mr. JUSTICE DENMAN ultimately committed Mr. Hinds to prison for seven days for contempt of Court.

The Court dismissed all the appeals, holding that when the action was gone the right of amendment was gone too.

COMPANIES' MEETINGS & REPORTS.

Anglo-American Telegraph Company (Limited).

The ordinary general half-yearly meeting of the proprietors of this Company was held at Winchester House, Old Broad-street, on the 31st ult., under the presidency of the Right Hon. Viscount Monck.

The SECRETARY (Mr. T. H. Wells) read the notice calling the meeting and the minutes of the last meeting, which were confirmed by the present meeting and signed as correct by the Chairman.

The CHAIRMAN: Gentleman, I presume you will take the report as read, and in moving its adoption I am happy to be able to announce a small addition to the dividend which we have been lately able to declare to you. The addition undoubtedly is small, but I think, in connection with the explanation contained in the report, it is not discouraging, and it contains the element of hope for the future. Gentlemen, you are aware that we are carrying on our traffic under two distinct arrangements—with the Direct United States Cable Company and the Western Union Company of New York. We have what is called a joint-purse arrangement—that is to say, we each pay our receipts into a common fund, and receive from it proportions of the aggregate. On the other hand, the parties to this joint purse arrangement and the Commercial Cable Company of New York have an agreement by which the tariff is fixed at a certain rate, and they each take as much as they can get at that rate. I believe that that arrangement has been fairly and honourably carried out on both sides; but it must be apparent to you that it introduces the element of competition, and that any circumstance which might arise to interfere with the carrying power of either of the parties to that transaction would affect their income. This is precisely what has happened to us during the past half-year. During that time one of our own cables—the old Brest cable of 1869—was twice out of working order. The cable of the Direct United States Company was also for a while inoperative. The two cables of the Western Union Company were also disabled, while during the whole of the time the cables of the Commercial Company, who are our competitors, were working uninterruptedly and with good effect. Gentlemen, with reference to this matter, I have only to reiterate and in every way to emphasise the observation made by my honourable friend, the Chairman of the Direct Cable Company, that it is the first duty of the Boards of the associated Companies to keep their cables constantly in repair, and whenever a mishap occurs to take care that the repair shall be effected with the greatest possible expedition. This is, of course, only the fortune of war. We have no right to complain of it, and I only mention it to you as the reason why we are not able to distribute a larger dividend than we propose on this occasion. Our cables are now in good working order. I hope they may continue so, and that the improvement in trade which has taken place all over the world may affect our traffic, and enable us to do better for you in the future. With respect to the expenses of the past half-year, on the face of them they look larger than those of the previous half-year; but if you come to analyse them, you will find that the increase consists altogether of extraordinary expenditure—restoration of buildings and so on—which is not likely to recur for a long time, and which cannot be treated as normal expenditure. During the period I speak of there has been spent on these objects at St. Pierre £1,000, at Valencia £1,000, at Heart's Content £400, and at Duxbury £200, making in all £2,600, which very largely exceeds the excess of expenditure shown in the accounts. Within the last year we have executed two works, one of which was alluded to by my noble friend at the last meeting—the diversion of the St. Pierre-Duxbury cable into deeper water. It has been for many years a source of vexation and expense to us by its liability to injury from the shallowness of the water in which it was laid. I trust now that it will give us much less trouble. The other operation which has been performed, and which has been referred to in the report, is that by an arrangement with the Western Union Company we have obtained the use of two wires into New York City, where we have established an office of our own, which will put us in direct communication with our customers at New York, whilst the extension of the Western Union Company's cables into New York will obviate the inconvenience—which from my residence in New York I can speak of with personal knowledge—of the interruptions of the land lines in the winter and spring by snow and storm. Gentlemen, we have often had discussions in this room with reference to the renewal fund. I do not want to raise any question about it on this occasion, but I think it will be satisfactory to you to know that the fund, which now stands in our books at £923,344, has been so well invested that it is worth, at the prices of the present day, about £60,000 more, and will give you in case you require to use it, with the spare cable in reserve, a full one million sterling for any purpose for which you may wish to apply it. I think this is not an unsatisfactory state of things so far as that is concerned. Since our last meeting this Company has sustained a great loss in the death of one of its most prominent members, Sir Daniel Gooch, who was an original member of the Board of this Company, and contributed by his personal exertions almost as much as any other man to the establishment and development of ocean telegraphy. In his profession he was a most eminent man, and his modesty was equal to his merits. It would have been impossible to have been connected, as I was for nearly twenty years, with such a man without having been impressed by his great intellectual abilities, and even more so by the high moral attributes which characterised him. Gentlemen, I think I express your feelings in thus giving utterance to our appreciation of the work of Sir Daniel Gooch, and our regret at his loss. We have chosen into his place Mr. Charles Burt, who is known to most

Digitized by Google

of you, and who, from his long experience of the business of the company and his great capacity, is, in my opinion, a worthy successor to Sir Daniel Gooch. With these observations I beg leave to move:

"*That the report of the directors and accompanying statement of accounts to December 31, 1889, submitted to this meeting be and the same are hereby received and adopted, and that the following dividends, less income-tax, as recommended by the Board, be now declared and paid—that is to say, a final dividend of 15s. per cent. on the ordinary consolidated stock for the year ended December, 1889, making, with £2 per cent. interim dividend already declared and paid by the Board by way of dividend on account, a total dividend for the said year of £2. 15s. per cent: upon the said stock, and a final dividend of £1. 10s. per cent. upon the Preferred ordinary stock for the year ended December 31, 1889, making, with 4 per cent. interim dividends already declared and paid by the Board by way of dividends on account, a total dividend for the said year of £5. 10s. per cent. on the said stock.*"

The MARQUIS OF TWEEDDALE seconded the motion.

Mr. JACKSON said he desired to ask two questions before the motion was put. His friend Mr. Smith, who for so many years had taken an active part at the meetings, had been compelled by a severe domestic calamity to be absent on that occasion, and had requested him to express on his behalf his general satisfaction with the report. Mr. Smith had desired him to ask a question with reference to the litigation with the French Cable Company. The Chairman had not mentioned it, but it was a deeply-interesting subject to the shareholders. If it had been a personal matter in which the estate of the Board had been concerned he did not think that so much delay as two years would have occurred, and that there would have been such a result as they now saw brought about. They had been hung up for two years, with the prospect of a further delay, and no satisfactory conclusion had been arrived at. He thought they might under the circumstances venture to ask the Board to use their best endeavours, and by using a little elbow grease, to use a vulgar phrase, endeavour to get a settlement arrived at by urging on the consideration of the French Government what he considered a scandal and a disgrace. The Company had a very strong case, and the French Company were endeavouring to benefit by their own *lâches*. The French Company, under the auspices of M. Pouyer-Quertier, had entered into a contract with the Anglo Company, and under the present administration that contract had been absolutely violated, and the shareholders had no evidence at present that any progress was being made in the matter. He hoped the Chairman would be able to assure them that everything had been done, and would be done to arrive at a settlement. They had heard that the French Company had taken out of the "pool" receipts somewhat exceeding £200,000 beyond what they had contributed to it. That was a very strong fact. The Anglo Company went to the Tribunal of Commerce, which one would have thought would be the special tribunal to judge such a case. There the verdict was given in the Anglo Company's favour, but it was appealed against by the Company which had captured the French cable, the decision there being confirmed. Then recourse was had to the Prefecteure de Seine, which was a political association, which had said that the contract was *ultra vires*. The consequence was that the matter was hung up all this period, and he thought that the shareholders had some right to urge on the Directors to use every exertion to bring the matter to an issue. This point, however, he raised mainly on behalf of Mr. Smith. His own question referred to a point upon which the Chairman had touched. Sir John Pender, at the meeting of the Direct United States Company, remarked, as the noble Chairman had just now mentioned, that it was the duty of the associated Companies whenever a cable was down to lose no time in repairing it, because the power of the Companies associated was then enlarged, enabling them to produce better results for the shareholders. There was another point which the Chairman had not referred to, which Sir John Pender had dealt with, and which he (the speaker) thought was a burning question with them. At the end of his speech Sir John Pender said that something must be done to increase the revenue of the Company, and he (Mr. Jackson) thought that the shareholders might call upon the Directors of the Anglo Company to associate themselves with Sir John in some way to produce a result which would be less inadequate for a trading company than they at present obtained. The starvation dividend of the funds was not one which a trading company ought to be satisfied with. The record of the Anglo Company was not a brilliant one. After 24 years' experience, with the advantage of great intellect on the Board, and men of unimpeachable position and integrity to conduct their affairs, they were only able on the face of it to pay a dividend of 2¾ per cent. In fact, it was only 2¾ per cent., for the shareholders would have observed that part of the expenses had been paid out of the interest which had been earned by the renewal fund. The total cost of the repairs for the half-year had been £37,000 odd, which was more than ½ per cent. dividend. Part of this had been paid out of the shareholders' savings—out of the interest of their accumulated fund which the Directors had so satisfactorily built up, with the assistance and patience of the shareholders. But he (Mr. Jackson) maintained that 2¾ per cent. was not a brilliant result, and one which they could not be satisfied with, nor could they congratulate their excellent Board upon it. Therefore, he desired to impress upon them the concluding observation of Sir John Pender at the meeting of the Direct Company, that something must be done to increase the revenue. When he (Mr. Jackson) joined the Company at its inception, the first tariff was a £2) message, and the next a £10 message. Afterwards the word system was adopted, and telegraphists had the opportunity of condensing their messages and reducing the expenses. But in the case of the Anglo Company the tariff had been reduced in the 24 years from the original amount to 5 per cent. He maintained that there was no record in this city of such a reduction. The Company, however, did not stop there, for owing to the coding system, which had become a high art, 20 words were enabled to be sent in one word, and the codists got the full benefit. He did not think that that was a fair condition of things for the shareholders. He, not being a merchant, had had occasion to send a message by the 3s. rate, and it cost him 14s. for the address. This was a question which the Board should direct their attention to, with a view of seeing if something could not be done to remunerate the shareholders for their long-tried patience. He had been glad to hear the Chairman say that they might look for a small and gradual improvement in the Company's affairs.

Mr. WOOD (Chislehurst) called attention to the following passage in the second paragraph of the report:—"For some weeks during the half-year under review, the whole of the traffic was thrown on to the cables of this Company, and, in consequence, its volume was sensibly diminished." He said he understood that the carrying capacity of their cables was far in excess of the business they had to do, and, therefore, the passage he had read rather astonished him. Mr. Jackson had referred to the dividends which they had paid for a good many years as not being very brilliant. That was so, but he (the speaker) was very thankful that they had not been worse. They might congratulate the Directors on one thing which was very brilliant in his opinion: that the Company had a reserve fund, with spare cable, amounting to the value of a million sterling, and he thought they might congratulate the Board on their foresight and prudence in having accumulated this fund. He regarded it as the backbone of the Company, and it made the concern a very much safer investment than many other companies that might be mentioned.

Mr. HUMPHREYS inquired the total cost of the repairs in the past half-year. In the revenue account the repairs were put down at £17,801, and he thought the whole of the repairs ought to be put to revenue account.

The MANAGING DIRECTOR (Mr. Weaver): You would not put it into revenue account if it were not chargeable to revenue?

Mr. HUMPHREYS asked what the total cost of the repairs for the half-year had been?

The SECRETARY: £17,801, *plus* the amount debited to the renewal fund.

Mr. HUMPHREYS said that that was just what his question referred to, and he strongly objected to what had been done. The amount of the repairs seemed very small, judging from the revenue account. The total expenses of the half-year, instead of being shown as £58,000, ought to appear as about £77,000. He thought that if these facts were always shown they would not be so continually stirred up by the threat of new cables being laid. The amount of the expenses stated in the report of £58,000 was misleading to the public, for the real fact was that the amount was nearly £80,000. He could not see anything to congratulate the Directors upon in the report. If the Directors were to have two Committees, one to attend to the electrical part of the business, and the other to attend to the financial part, he thought that the £2,600,000 Deferred Stock would soon come in for a better dividend. The Direct United States Company paid 3½ per cent. dividend and put by another 2½ per cent. to the reserve, and the Board of that Company were to be congratulated and thanked for the successful way in which they conducted their business. The Anglo Company, however, could not even pay a 3 per cent. dividend, but only 2¾ per cent., and that with difficulty, and they would not have been able to make this distribution if the renewal fund had not been charged with part of the cost of repairs. They ought not to divide their expenses with a fund which probably the general public never thought of looking at—the renewal fund.

Mr. JOHN NEWTON said that in the past the shareholders had strongly dissented from such large sums being put to the reserve or renewal fund, and if at the present time the revenue from the investments paid for part of the expense of the repairs he thought they ought to do so. In any case, however, the point raised was a matter of book-keeping, and he did not think it was for the shareholders to interfere with the judgment of the Directors as to how the books were kept. As long as the broad result was as it now stood the shareholders ought to be satisfied. He desired to express his satisfaction at the remarks which had fallen from the Chairman relative to the immense services which had been rendered to submarine telegraphy by the late Sir Daniel Gooch. Not only did the deceased gentleman advance the submarine telegraph system by the labours which he bestowed upon it, but by the money which he had put into the enterprise. No doubt he had received an abundant reward, but not half the amount that he ought to have received, and which the shareholders ought to receive for the grand work in which they had taken part. Magnificent divivends were paid by gas and water companies, who had not rendered half the services to civilisation which their Company had done, and they could not but feel dissatisfied with the amount distributed among them. He desired to express his satisfaction at the selection which the Directors had made of a gentleman from the City to fill the seat at the Board rendered vacant by the death of Sir Daniel Gooch. He preferred to see City men on the Board to gentlemen who came from the West End.

The MARQUIS OF TWEEDDALE: Our noble Chairman has asked me, as his voice is not as strong as it has been, to reply to the questions which the honourable proprietors have put to him. With reference to Mr. Jackson's question regarding the case in the French Courts, I can assure him and the whole of the shareholders present that everything has been done that could be done to bring it to a settlement. The intelligence of our lawyers, and of our able manager, has been directed to expedite the settlement of that case. I need not, however, point out to you that we cannot bring any influence to bear on the French courts; but we have reason to believe that that case may be settled before we meet you again in six months' time. With respect to Mr. Wood's question as to the last part of the second paragraph of the report, I think it is sufficient to point out to him that it is inevitable that a Company which loses three of its cables must be crippled with respect to the traffic which it may expect. The traffic, as you are all aware, between this country and America is crowded into a very few hours, and, of course, the more cables we have at our command the more expeditiously is the business transacted. With

Digitized by Google

respect to something being done to increase the income, that is, I need hardly say, the chief, if not the only, occupation which the Directors have to turn their attention to. Sir John Pender said that the time has come for doing it. I think the time came a good while ago for doing it if it were possible. But you must remember that the tariff cannot be fixed by ourselves. We have not only partners in this business—important and influential ones—but we have also got opponents, and until we all agree, and become a happy family with respect to this question of the tariff, it is impossible to make any alteration, even if an alteration were desirable. But I think the impression on our minds, and on the minds of our friends, is that it would not be desirable to make any alteration in the existing tariff. The tariff seems to meet exactly the kind of traffic which we have to convey. If we were to increase the tariff, there is every reason to suppose that we should bring in further competition. I think this is a general answer to a great deal that has been said to-day by Mr. Jackson. You must remember that the Atlantic Ocean is open to any number of persons who choose to spend their money or lose it in laying a cable. That is the difficulty which we and other Companies have to contend with respecting the income we should like to enjoy. With regard to the total cost of repairs, the total cost of renewals and repairs is composed of two items. Something like £17,000—nearly £18,000—includes the repairs of the Brest-St. Pierre cable, and the repairs and diversion of the St. Pierre-Duxbury cable. This amount was charged to renewal fund, and £17,800 was charged to revenue account for the expenses of the ship "Minia," the value of the cable expended and the charter of the "Britannia." These two amounts together come to about £36,000.

A SHAREHOLDER asked what sum was in dispute in connection with the litigation with the French Company.

Mr. CHARLES BURT: An unknown quantity—an enormous sum if we can get it all.

The SHAREHOLDER: It is not in the accounts?

Mr. BURT: Oh, no.

The CHAIRMAN then put the resolution in the usual way, and it was carried unanimously.

On the motion of the MARQUIS OF TWEEDDALE, seconded by Sir JAMES ANDERSON, Viscount Monck was re-elected a Director, as was also Mr. Samuel Barber, on the motion of the MARQUIS OF TWEEDDALE, seconded by Mr. FRANCIS A. BEVAN.

Mr. Joshua Dean was re-elected an auditor for the current year, and to fill the vacancy in the auditorship caused by the retirement, on account of failing health, of Mr. Francis Glass, Mr. John Gane was elected.

Mr. JACKSON then proposed a vote of thanks to the Chairman and Directors, and expressed the gratification which he was sure all the shareholders had at seeing Viscount Monck presiding over them again. His lordship's presence was a guarantee and an assurance to the shareholders that whatever could be done by goodwill would be done.

The motion was seconded and carried unanimously.

The CHAIRMAN briefly returned thanks, and the proceedings terminated.

The Cuba Submarine Telegraph Company (Limited).

The 37th ordinary general meeting of this Company was held at the Company's offices, 58, Old Broad-street, on Wednesday last, under the presidency of Mr. Thomas Greenwood.

The SECRETARY (Mr. James Scott) having read the notice convening the meeting, the report of the Directors (which we give below) and statement of accounts were taken as read.

The CHAIRMAN: Gentlemen, it is usual on occasions like this to direct your attention to the prominent features in the report in the order in which they are therein given; but I must ask you to-day to allow me to refer first of all to paragraph 9, because it relates to a personal matter. Mr. Low, who has been occupying the chair since the lamented death of Mr. de Mancha, felt it necessary to resign the duties which he had so honourably performed. I need scarcely say that the Board did their very best to induce him to withdraw his resignation, but when he gave the reasons he had for doing so, we felt it was necessary to relieve him at once of his duties, and that has been done. The Board have been good enough to request me to take the chair, and I trust, as Mr. Low has consented to remain on the Board, that he will give us the benefit of his very long experience and knowledge, for he has been a Director of the Company from the beginning, and that our affairs in the future will continue to be conducted satisfactorily to you, as I am sure they have been in the past. Turning to the accounts and the general business of theday, if you have made a comparison between these accounts and those of the corresponding period of the previous year, you will have noticed a number of small items not worth consideration to-day. There are two, however, of importance, upon which I wish to say a word or two. You will find that the expenses are about £1,500 more than they were twelve months ago, and that the receipts are about £1,500 less than they were at the same period. These two sums together make a difference in our available balance of about £3,000, and account for the fact that we have carried to the reserve fund this year only £1,000, as against £4,000 in the corresponding period last year. Adverting now to the item of expenses, you will perceive that the whole of this addition has been caused by the cost of the repair of the Batabano-Cienfuegos cable, and the amount paid to the Government for the use of their wire during the short time the cable was broken. Fortunately for us, twelve months ago we had no such repairs, but one does not expect to carry on a business of this kind without having at some time or other to encounter expenses in the repair of cables, and although it appears that there is a difference of £1,500, compared with the previous year, this arises solely from the fact that there were no expenses of this kind in that year. The average expenses for the last seven years for the repair of cables have been £2,338 per annum, and we have been obliged this half-year to charge to revenue about £1,500, which you will see is a little more than the general average. But if I were to leave my quotation of figures there it might mislead you, because the revenue of the Company bears a considerably larger sum than that for renewals and repairs; in fact, for the replacement of one of the cables—I refer to the 1881 cable—we charge against revenue £3,750 per annum, and that has been going on for nine years, and there are three years yet to come in which a similar amount will be charged to that account. But when that is done we shall have got our cable paid for altogether out of revenue, and no further expenses will appear under that head except repairs in the usual way. During the twelve years the contractor has to repair that cable, but when his last instalment has been paid we shall ourselves have to pay for any repairs that may have to be made. Adverting to the other side of the accounts now, that is to the diminution in the receipts by £1,500, I wish to observe that, although it may appear paradoxical to say so, it is nevertheless a satisfactory feature. We have reduced our tariff upon by far the larger portion of our business by some 25 per cent. The through rate used to be 67 cents per word: it is now 50 cents, and the Board congratulate themselves and you upon being able to make so large a reduction in our rates with so small a diminution in the average receipts. I am pleased to mention also that last month our returns were £3,150, as against £3,220 in the same month last year, or a diminution of only £70 comparing one month with the other; and we do hope that the increase of traffic which must necessarily come by the diminution of our charges will continue, and that we shall have as large an income at the reduced as we had at the higher rate of charge per word. I think that this must be satisfactory to the shareholders and everybody concerned, because it is manifest that no company can hold a monopoly such as we do without taking into consideration the needs of the public who use our lines; and our position will be firmer, and we shall be less likely to be opposed at the lower than at the higher rate of tariff. That brings me to make a remark or two upon the circumstances in which we are placed in relation to the French Cable Company. You will find the subject referred to in paragraph 6 of the report. The island of Cuba, as you know, is about six times as long as it is broad, extending practically from east to west, the long sides therefore being north and south. Our lines begin at Havana, on the north side, where they join the cables of the International Ocean Telegraph Company, whose lines connect Havana with the North American continent, so that messages to and from the West Indies must necessarily pass through that company's line and the Atlantic cables to Europe. From Havana our line runs overland to Batabano, on the south side of the island, whence our cables run along the south coast, touching at Cienfuegos, to Santiago, our terminus at the east end of the island. There we join the West India and Panama Company's system, which goes on to Jamaica, thence passing, but not touching Hayti, to the other islands included in that Companys' system. We have agreements with the West India and Panama Company, and also with the International Ocean Telegraph Company, by which we control the traffic through all these lines. But a French company was started some little time ago. It has laid cables from Venezuela, touching an island *en route* to San Domingo, and thence by a land line to the sea at the north side, and cable to Mole St. Nicholas, Hayti, not far from Santiago, where our lines commence. They had previously obtained permission to lay a line to Cuba, touching an insignificant place, and then continuing their cable from there to Santiago, so that messages to and from Venezuela and Europe pass *viâ* Santiago through our lines to their destination. All this is very satisfactory so far as it has gone, and our revenue has been considerably increased by the traffic which the French company bring to us, and we hoped that, by reducing our rate, we should have secured their traffic permanently. But that company has made application to the Government of Spain for permission to lay a line of their own from Havana, our western terminus, along the north coast to a point near Santiago, with which it now has telegraphic communication, so that, if that line were made, there would be direct competition between it and our own lines, for it is manifest that it makes no difference to anybody sending a telegram whether it goes by the north or the south side to the same place. Under the circumstances the Board felt it necessary not only to protest against this, but to use their best endeavours to get the Spanish Government to refuse the application. But having failed in that, they have initiated proceedings in Madrid with the view of annulling this Royal Order which, I understand, usually precedes the granting of any concession, and I hope we may succeed in doing this. But even supposing we do not, there are several things to be considered before we arrive at the conclusion that our traffic is likely to be interfered with. That company will have to get their capital for carrying out the concession, and when they have got the capital they will find that the cost of the line will make a great dip into a quarter of a million sterling. My own opinion is, that at the charge we make to them it would be much more profitable for them to send their messages by our cables than to lay one of their own, unless they have some ulterior object of which we have not been informed and can only surmise. Gentlemen, I think I have laid the facts of the case before you, and if there be any other information which the shareholders wish to have, I should be happy to give it, for both you and the Directors are in the same boat, and any knowledge which we possess, and which we can fairly give you without interfering with the business of the Company, we shall be most happy to supply. With these remarks I beg to move—

"*That the report and accounts for the half-year ended December 31st last now submitted, be received and adopted.*"

Digitized by Google

Mr. LOW seconded the resolution, which was unanimously adopted without discussion.

The CHAIRMAN then moved—

"That the following dividends for the half-year be now declared upon the shares of the Company, viz., at the rate of 10 per cent. per annum, subject to income-tax on the Preference shares, and 9 per cent. per annum, free of income-tax, on the ordinary shares, payable on and after to-morrow."

Mr. LOW seconded the motion, which was carried *nem. con.*

Mr. KEENLYSIDE proposed a vote of thanks to the Chairman, the Directors, Secretary, and staff for their successful conduct of the Company's business.

Mr. JOHN PITCHFORD seconded the motion, which was carried unanimously.

The CHAIRMAN: On behalf of the Board I have to thank you very much for your appreciation of their services. I can assure you they have done their best, and are satisfied to think that they have pleased the shareholders, which they hope to continue to do. As the Secretary's name has been mentioned, I should like to say that, though my period of this office has been short, I have been acquainted with Mr. Scott for many years, and I do not think it would be possible for us to have a more efficient Secretary, or one who could take a greater interest in the welfare of the Company.

The proceedings then terminated.

The following is the report of the Directors for the half-year ended December 31st last, referred to above.

1. The balance sheet and accounts are for the half-year ended December 31st last.

2. From these it will be seen that the gross receipts (including the balance brought from last account) amount to £19,705 18s. 2d., and the gross expenditure (including the half of the annual payment on account of the 1881 cable, and the expenses in connection with cable repairs) to £8,101 6s. 8d., leaving a sum of £11,604 11s. 6d. to the credit of revenue account.

3. Of this the sum of £1,000 has been added to the reserve fund, increasing that fund to £91,000.

4. The dividend on the preference shares will absorb £3,000, and leave £7,604 11s. 6d., out of which the Directors recommend the payment of a dividend on the ordinary shares at the rate of 9 per cent. per annum, free of income-tax, the balance, £404 11s. 6d., being carried forward to the current half-year's account.

5. The gradual and continuous increase in the income of the Company, together with the accession of business on the opening by a French Company of telegraphic communication from this Company's terminus in Santiago to Venezuela, warranted the expectation that a large reduction might be made in its through tariff without materially affecting the shareholders' dividend, and with a view to secure by its lines the permanent carriage of the French Company's through traffic to and from America and Europe, and also to increase the traffic to and from the West Indian Company's system, the rate for all through messages was reduced about 25 per cent. from July 1st last. It is very satisfactory to note that the aggregate receipts have suffered comparatively little by the change.

6. But the Directors regret to have to report that although the through rate has been thus reduced and all other proper facilities given to the French Company, that Company has applied to the Spanish Government for permission to have a line by land, or a cable by sea, almost parallel with the lines owned by this Company. Protests have been lodged by the Board with the Spanish authorities, but apparently without avail, for a Royal Order has been issued refusing the land line, but conditionally granting a cable from a place adjacent to this Company's eastern terminus at Santiago (with which town the French Company already has telegraphic communication), along the north coast to Havanah, this Company's western terminus, so that the proposed line, if allowed, will take from this Company the whole of the traffic under the control of the French Company, but now carried by this Company, and may be in competition, by the north coast, with this Company's lines on the south coast. The Board has therefore felt it to be imperative to commence proceedings in the proper Court in Madrid to protect this Company's concession and interests.

7. The duplication of the line between Batabano and Cienfuegos has been postponed until the next favourable season. The tenders invited by the Board were not completed, but were under the consideration of the cable manufacturers when the strike difficulties commenced. The tenders were very much higher than the Board expected them to be, and as the existing cable was working satisfactorily, the delay of a few months was deemed to be desirable. That cable has lately been broken by a ship's anchor, but has been speedily repaired, and is now at work as usual.

8. The Cienfuegos-Santiago 1875 cable, being faulty at both ends, will be repaired as soon as possible. The traffic is carried by the 1881 cable.

9. In accordance with Mr. Low's request he has been relieved of his duties as chairman, which have been undertaken by Mr. Greenwood, but the Directors are pleased to add that Mr. Low retains his seat on the Board.

City of London and Southwark Subway Company.

The following is the report of the Directors, to be presented to the shareholders at the eleventh half-yearly ordinary meeting of the Company, to be held at Winchester House, Old Broad-street, E.C., on Tuesday, the 18th inst., at 12 o'clock:—

During the past half-year the works of the Subway have made considerable progress and are now approaching completion.

The work of driving through the wet bed of gravel at Stockwell has been steadily proceeded with, and one of the tunnels is now completed throughout, and the other tunnel is being rapidly advanced. The underground stations are all nearly finished, and the station buildings on the surface at Great Dover-street are roofed in, the alterations to the building at King William-street have been completed, and the Company's offices are now established there. The hydraulic lifts are being erected at King William-street and Great Dover-street Stations, and the rails have been laid in both tunnels from the City to the "Elephant and Castle," and also for a considerable distance on the Stockwell extension. At the depôt at Stockwell the boiler-house has been completed and six boilers fixed. The engine-house is nearly ready for the reception of the engines and dynamos, and the carriage sheds are being erected. The inclined road leading from the depôt to the tunnels is nearly finished. Messrs. Mather and Platt have had an electric locomotive and carriages running experimentally for some time between the King William-street and Great Dover-street Stations.

As the present authorised lines stop at Stockwell, about a mile short of the great centre of traffic meeting near the "Plough" at Clapham, your Directors have deemed it advisable to deposit a Bill in Parliament asking for power to extend the line to that point, the works for which can be carried out at a lower comparative cost than the existing works, and the approval of the proprietors will be asked at a special meeting called for that purpose. They propose also to alter the name of the Company to that of the City and South of London Railway Company, as being more in harmony with the present nature and object of the undertaking.

Powers are being sought in the ensuing session of Parliament by an independent company for the construction of an underground railway on the same principles as the City of London and Southwark Subway, from Bayswater along Oxford-street and Cheapside to the City, with a junction with our line at Arthur-street West, just before it enters the King William-street Station. The junction as at present proposed would not be satisfactory to this Company, but it is possible that arrangements may be made to

PATENT
SILICIUM BRONZE AND SILICIUM COPPER WIRE.
The best for overhead Telephone and Telegraph Lines,
AND ALL ELECTRICAL PURPOSES.
Hard Drawn High Conductivity Copper Wire.
ROLLED AND DRAWN
PHOSPHOR BRONZE.

PHOSPHOR BRONZE
BEARINGS, BUSHES,
AND OTHER PARTS OF
ELECTRICAL MACHINERY.
SOLE PROPRIETORS of the British, Indian and Colonial Patents,
THE PHOSPHOR BRONZE COMPANY (Limited),
87, Sumner Street, Southwark, London, S.E.
WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

Digitized by Google

effect a junction between the two lines beneficial to both companies. It has also been deemed expedient to include powers in the Company's Bill for the acquisition of the necessary land for the construction of a station near the London Bridge termini of the London and Brighton and South-Eastern Railways.

The Directors who retire by rotation are Messrs. C. S. Grenfell and Alexander Hubbard, who are eligible for re-election.

The Auditors likewise offer themselves for re-election.

The India-Rubber, Gutta-Percha, and Telegraph Works Company (Limited).

The following is the Directors' report for the year ending Dec. 31, 1889, to be presented at the twenty-sixth ordinary general meeting of the shareholders, to be held at the Cannon-street Hotel, on Friday, the 14th instant, at half-past one o'clock:—

The accounts show the net profit for the past year to be £57,748. 9s. 1d. Adding £25,087. 17s. 7d. brought forward, and deducting £20,800 interim dividend paid in July, there remains a disposable balance of £62,036 6s. 8d. The Directors recommend the distribution of a dividend of 10s. per share, free of income tax, amounting to £20,800, making, with the interim dividend, a total payment for the year of 10 per cent., and leaving £41,236. 6s. 8d. to be carried forward. The Company's general business has been well maintained; and the laying of the 800 miles of cable mentioned in the last report was successfully completed. At the instigation of unprincipled agitators, almost all the Company's workpeople went out on strike in the middle of September, and remained out from ten to twelve weeks. The result to them was the loss of about £20,000 which they would have received in wages. The loss to the Company was but small, as other means were available for the execution of orders. For the greater convenience of the Company's business, freehold premises have been purchased at Liverpool adjoining those hitherto occupied, the lease of which runs out in the present year; and in consideration of an extended lease at a reduced rent, the premises in Cannon-street have been rearranged and greatly improved, and fitted with electric light. The Company's works and machinery are in efficient working order.

Mr. Silver and the Hon. Henry Marsham, the Directors retiring by rotation, offer themselves for re-election. The auditor, Mr. Weise, retires, and is re-eligible.

The North Metropolitan Tramways Company (Limited).

The fortieth ordinary half-yearly general meeting of this Company was held at the Cannon-street Hotel on Wednesday, Mr. G. Richardson presiding.

The CHAIRMAN, in moving the adoption of the report, said he thought shareholders would agree with him that on the whole it was satisfactory. The accounts showed a total increase in receipts of £20,000. As a Company they had carried a large additional number of passengers, the aggregate for the year being 66,000,000. The penny fares had been a great success. There indeed had been such an increase in their traffic that they proposed to go to Parliament this year for power to increase their capital, with which to obtain the necessary additions to their rolling stock. In the same Bill power would be sought to apply electric or other mechanical traction over such portions of their system as they thought advisable. Complete success had attended their experiments with electric traction. Their installation of electric working indeed was the most successful in the kingdom so far, and they anticipated that the more general adoption of electricity would prove of great economic value. They had hitherto had to get power by a sort of licence from the Board of Trade. Now when the present Act expired, they would either have to get the power renewed or it would lapse, which would be regretable. They intended, as time went on, to adopt it on the various portions of their line that might be found suitable.

Mr. J. M. GILLIES seconded the adoption of the report.

Mr. JACKSON and other shareholders congratulated the Directors on the presentation of the best report they had yet laid before the proprietors. The first-named hoped there would be no difficulty in obtaining powers for utilising electric traction. There would be an economy of something like 20 per cent. In America there was ten times the amount of electric traction there was in this country.

Answering questions, the Chairman said the cost of electric traction was about 4½d. per mile, including drivers. The cost of horsing cars, without drivers, was 4·32d., and conductors, &c., might be put roughly at another penny a mile. The adoption of electricity would not, he thought, necessitate the relaying of their lines. All the lines they were now putting down were laid with heavy rails, such as were used in Barking-road, and wherever repairs were necessary the same metals were being used.

The report having been adopted, a dividend at the rate of 9¾ per cent. was declared, carrying forward £5,025 to the revenue account for the next half.

The retiring Directors and auditors having been re-elected, the meeting was declared special, when approval was expressed of the Bill the Board proposed to introduce into Parliament, the main objects of which the Chairman had already explained.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended January 31st amounted to £5,249.

CUBA SUBMARINE TELEGRAPH COMPANY.—The estimated traffic receipts of this Company for the month of January were £3,150, as compared with £3,221 in the corresponding month of last year. The receipts for the month of October, estimated at £2,900, realised £2,103.

DIRECT SPANISH TELEGRAPH COMPANY.—The traffic receipts of this Company for the month of January were £2,415, against £1,880 in the corresponding period of last year, an increase of £535.

EASTERN TELEGRAPH COMPANY.—The traffic receipts of this Company for the month of January amounted to £59,478, as against £65,835 in the corresponding period of 1889, a decrease of £6,357.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY.—The traffic receipts of this Company for the month of January 1890, amounted to £40,610, as compared with £41,820 in the corresponding period of 1889, a decrease of £1,210.

ELMORE'S PATENT COPPER-DEPOSITING COMPANY.—The secretary of this Company announces that the first section of the Company's works has been completed, and that the operations of manufacture have been successfully commenced. The Directors are arranging for an exhibit of the Company's manufactures in London.

GREAT NORTHERN TELEGRAPH COMPANY.—Messrs. Hambro and Son announce the numbers of this Company's debentures of 1833 (Series "B") drawn for payment on the 1st March.—The traffic returns of this Company for the month of January amounted to £19,600, against £22,400 and £21,400 in the corresponding months of 1889 and 1888.

THE UNION TRUST COMPANY OF NEW YORK.—This company notify that, in accordance with the provisions of the deed of trust executed by the Western Union Telegraph Company to the Union Trust Company of New York as trustees, 14 bonds, amounting to £2,100, have been drawn by lot for redemption on March 1st next at the offices of Messrs. Morton, Rose and Co., Bartholomew-lane, E.C.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended January 31st, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,996.

WEST COAST OF AMERICA TELEGRAPH COMPANY.—The traffic receipts of this Company for the month ended January 31st amounted to £6,225.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The receipts of this Company for the half-month ended January 31st show an increase of £651 as compared with the corresponding period.

THE NON-CONDUCTOR OF ELECTRICITY.

WAREHOUSE.

VULCANISED FIBRE,

PATENTED.

This new material is supplied in two qualities, Flexible and Hard.

The FLEXIBLE is a substitute for Leather, Rubber, Gutta Percha, &c., and is extensively used by Brass Founders, Axle Makers, Hydraulic, Sanitary, and other Engineers, Pump Makers, Carriage Builders, &c.

It makes the best Hot and Cold Water Packings, and for Axle Washers of all kinds it is unequalled.

The HARD is a substitute for Metals, Hard Wood, Ivory, Vulcanite, Ebonite, &c., and is a good Insulator.

Sold in sheets, 5ft. 6in. by 3ft. 6in., varying in thickness from 1-50in. to 1in.

FLEXIBLE, 2/- per lb.; HARD, 2/3 per lb.

FACTORY.

MOSSES & MITCHELL, 70 Chiswell-st., London, E.C.

Digitized by Google

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Wednesday, Feb. 5, 1890.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending Feb. 5, 1890.	
							Highest.	Lowest.
£			**TELEGRAPHS.**		£ s. d.			
1,770,360	Stock	12/6	Anglo-American	50½ 51½	5 6 10	Jan., Apr., July, Oct.	50⅞	..
2,614,820	Stock	25/0	Do. Preferred	86 87	6 6 5	,, ,,	87⅜	86⅞
2,614,820	Stock	...	Do. Deferred	15 15½	...	February	15 9/16	15⅛
130,000	£10	3/0	Brazilian Submarine	12 12⅜	6 0 0	Mar., June, Oct., Dec.	12⅞	12¼
112,900	£100	5%	Do. 5 per Cent. Bonds	99 101	4 19 0	January and July	...	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	104 107	4 13 6	June and December.	...	...
16,000	10	9/0	Cuba Submarine	14 14½	6 4 2	February and August	14½	14
6,000	10	10%	Do. Preference 10%	19½ 20½	4 19 9	,, ,,	...	...
12,931	5	2/0	Direct Spanish (£4 paid)	4 4½	4 8 11	March & September	...	...
6,000	5	10%	Do. Preference 10%	9 10	5 0 0	April and October	...	...
60,710	20	3/6	Direct United States	10 10¼	6 16 7	Jan., Apr., July, Oct.	10½	...
380,000	10	2/6	Eastern	13⅞ 14⅛	4 12 0	,, ,,	14⅜	13 13/16
70,000	10	6%	Do. 6 per Cent. Preference	14¼ 15¼	3 18 8	,, ,,	15 7/16	15
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock	105 107	3 14 9	May and November.	106⅞	106½
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	106 109	4 11 9	February & August	106½	...
250,000	10	2/6	Eastern Extension	13¾ 14	4 12 10	Jan., Apr., July, Oct.	13 15/16	13 13/16
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	100 102	5 17 8	February & August	...	...
473,000	100	5%	Do. 5 per Ct. (Austrln. Gov. Sub.) Debs. 1900	102 105	4 15 3	January and July	102½	...
179,177	10	1/9	Globe Telegraph and Trust	8⅝ 8⅞	5 15 6	Jan., Apr., July, Oct.	8 13/16	8⅝
178,992	10	6%	Do. 6 per Cent. Preference	14½ 14¾	4 1 4	,, ,,	14⅝	14½
150,000	10	5/0	Great Northern	15½ 16	4 13 9	Jan., July, and April	15⅝	15½
17,000	25	12/6	Indo-European	40 42	5 19 1	April and October	41¼	...
9,000	8	4/0	Reuter's	7 7½	5 6 5	April and October	7¼	...
15,609	10	3/6	West African Telegraph	9½ 10½	...	...	9⅝	...
300,000	100	5%	Do. 5 per Cent. Debentures	99 102	4 18 0	March & September	...	...
30,000	10	5/0	West Coast of America	10¾ 11¼	...	January and July	...	...
150,000	100	8%	Do. Debentures 8%	119 124	6 9 1	June and December	...	...
88,321	10	nil.	West India and Panama	2⅞ 3⅛	...	...	3⅛	2⅞
34,563	10	12/0	Do. 1st Preference 6%	11½ 12	...	April and October	12	11⅞
4,669	10	10/0	Do. 6 per Cent. 2nd Preference	14⅛ 15½	3 17 5	...	...	...
45,181	15	6/0	Western Brazilian	9¾ 10¼	7 6 6	May & November	10	9 11/16
$1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	118 122	5 14 9	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	102 104	5 15 5	March & September	...	...
			TELEPHONES.					
224,850	14/0	5%	Consolidated Telephone and Maintenance	1 1/16 1 1/8	...	Yearly	1⅛	...
220,000	£1	3%	Oriental (11s. paid)	⅝ ⅞	3 5 11	...	...	...
80,000	5	6%	National	5¼ 5½	...	June and December.	5 7/16	5
55,000	5	3/0	United River Plate	4¾ 5¼	...	January and July	...	...
			ELECTRIC LIGHT.					
500,000	10	...	Metropolitan Electric Supply (£5 paid)	4½ 5	...	...	4⅝	4½
79,934	5	6%	Swan United (£3. 10s. paid)	5 5½	3 16 5	...	5¼	...
			MISCELLANEOUS.					
87,350	12	12/0	Telegraph Construction and Maintenance	45 47	5 2 3	March and July	46¼	45½
41,600	10	10/0	India Rubber, Gutta Percha & Telegraph Works	18⅓ 19½	5 2 7	February & August	19⅛	18

JABLOCHKOFF'S
BISTRIBUTION PATENT

(Being a Patent for "Producing and Dividing Electric Light," No. 1996 of 1877.)

THE ELECTRICAL ENGINEERING CORPORATION (LIMITED)

Are Proprietors of the above Patent, and Warn the Public against Infringement.

The following are Licensees:—

Anglo-American Brush Electric Light Corporation, Limited.
Crompton & Co., Limited.
S. Z. de Ferranti.—London Electric Supply Corporation, Limited.
W. T. Goolden & Co.
Hammond & Co.
Wilson Hartnell.
Johnson & Phillips.
Laurence, Paris & Scott, Limited.
Nalder Brothers & Co.
Paterson & Cooper.
Ernest Scott & Co.
Siemens Brothers & Co., Limited.

3, Prince's Mansions, Victoria Street, Westminster, MANVILLE & MADGEN, *Managing Directors.*

Digitized by Google

THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 613.—Vol. XXIV. FRIDAY, FEBRUARY 14, 1890. Price Fourpence.

NOTES.

The genuinely hearty vote of thanks which was accorded to Prof. Silvanus Thompson on Monday evening last at the close of his series of Cantor lectures on "The Electro-Magnet," together with the very large attendance throughout the course, were a sufficient proof that the efforts of the lecturer had been thoroughly appreciated. The electro-magnet, when treated historically, theoretically, and practically, is a somewhat unwieldly subject to deal with in the short space of four one-hour lectures; but so far as this difficult task could be accomplished it was accomplished. Mr. Preece, in proposing the vote of thanks, remarked that Prof. Thompson's classic lectures on "Dynamo-electric Machinery," delivered in the autumn of 1882, had been the forerunners of *the* standard work on the subject, and expressed a hope that a similar result would follow from the course of lectures on "The Electro-Magnet"—a hope which we have every reason to believe will shortly be realised. Prof. Thompson, it goes without saying, did what he could to rescue several already half-forgotten scientific worthies from unmerited oblivion. Sturgeon was duly installed in his niche as inventor of the electro-magnet, and Meran, the first to be inspired with the idea of the electric trembling bell, was not passed over. It also goes without saying that Prof. Thompson had some very severe remarks for his particular *bête noire* the text-book, with its fondness for archaic terms and exploded ideas.

The experience of the past eighteen months has very clearly shown that the Electric Lighting Act of 1882—that supreme effort of paternal legislation—is an eminently defective piece of machinery, and, indeed, but for the intervention of that *deus ex machina* the Board of Trade, it would be practically unworkable. In an article which will be found in another column the unsatisfactory condition of the law with regard to electric lighting is made tolerably apparent, and we can only hope that if the new Act for which Mr. Hayward calls is not within the region of practical politics, the Board of Trade will see its way to the adoption of some of his suggestions, notably those relating to the municipalities who profess their readiness to start electric lighting stations and fail to do so. Mr. Hayward emphasises, as we have more than once done, the confused state of the law with regard to electric inspectors as set forth in the Metropolitan Provisional Orders granted last Session. These functionaries, it will be remembered, are to be paid and appointed by one party, their fees are to be fixed by a second party, and they themselves are to be subject to the general approval of a third party—a condition of affairs by no means conducive to efficiency.

In our correspondence columns will be found a letter from Mr. H. J. S. Heather, expressing considerable scepticism as to the actuality of the figure (4½d. per car mile) at which the Electric Traction Company professes its readiness to work the whole system of the North Metropolitan Tramways Company. The incredulity of our correspondent may possibly be justified by the facts of the case, but a careful analysis of the figures relating to the Brussels tramways to which he refers does not altogether bear out his contention that the Traction Company's charge of 4½d. per car mile cannot be remunerative.

The cost of accumulator renewal at Brussels, M. Michelet states, was 1½d. per car mile (9 centimes per car kilometre), motor and gearing renewals amounting to about 1d. per car mile (5·74 centimes per car kilometre). The latter figure might well be reduced for English plants by 25 per cent., *i.e.*, to ¾d. per car mile. Again, while the Barking-road section is by no means an easy piece of road, the Brussels line, over which the Julien cars were run, is still less ideal. It must also be remembered that the cost of renewals is higher in Brussels than in London, and that the experience of the idiosyncrasies of accumulators gained by the Electric Traction Company in its preliminary experiments can scarcely have failed to have resulted in a material diminution of the renewal account. Taking these and other factors into consideration, 1¼d. per car mile would not now be an unreasonably low figure to allow for accumulator renewals. Making these deductions from the Brussels figures the Electric Traction Company have left 2½d. per car mile for steam power, wages, depreciation of stationary plant, miscellaneous expenses, and profit. That storage-battery traction cannot as a rule be so economical as a well-managed overhead system has always been our opinion. So long, however, as the sight of an overhead wire is an eyesore to our local authorities, accumulator cars, so soon as they have conclusively shown their superiority to horse cars, are likely to come into more general use than those which obtain their current from an external source.

A practical method of calibrating thermo-couples for high temperatures is described in the February number of the *Phil. Mag.*, by Carl Barus, who has investigated the varia-

Digitized by Google

tions caused in the boiling points of various metals by changes in external pressure. The result of these investigations, combined with the known boiling points of different metals at the atmospheric pressure, enables the calibration to be performed at all points over a very large range of temperatures. The apparatus for fusing the metals used in the experiments is described in detail. A platinum iridio-platinum thermo-couple was employed, the thermo-electric constants of which were measured, by a null method, in terms of the electromotive force of a LATIMER CLARK cell. It was, however, found best to use a torsion galvanometer, and to directly express the thermo-electromotive forces in terms of the twist of a platinum fibre. The instrument used was 135 cm. high, and when the needles of the galvanometer were strongly magnetised, it was found that a platinum wire 0·018 cm. in diameter was sufficiently thin. In order to avoid the error caused by the directive force of the earth's magnetism the needles were always brought back to zero by turning a torsion head at the top of the instrument. A mirror was attached to the needle, and a telescope and scale were employed to measure the fractions of a degree. A thermo-couple calibrated in this way should form an invaluable instrument for the measurement of high temperatures.

IN the same journal Prof. ERIC GERARD, of Liège, describes a process of plotting curves by the aid of photography. An induction coil is used to produce a spark between a strip of magnesium and a carbon point. This spark is thrown on a concave mirror, attached to a galvanometer-needle, and is thence reflected to the sensitised paper covering a rotating cylinder or other moving screen. A short white spark, invariable in position, is obtained by connecting the terminals of the secondary coil to the coatings of a Leyden jar. The breaks in the primary circuit are effected by means of a tuning fork, so that the successive spark photographs occur at regular known intervals of time. The error due to irregular movement of the scale is thus avoided, without the complication introduced by the usual method of taking a separate time curve. The method is illustrated by a photographed curve, showing the variations in the field of an electric motor. A short length of wire, fixed to the armature parallel to the axis, is connected by suitable collectors with a galvanometer whose moving parts have little inertia. The lateral displacement of the photographed spark then measures the strength of the induced current, while its number represents the time.

M. LEDUC has recently shown that the alteration in resistance which bismuth undergoes when placed in a magnetic field varies considerably with the temperature of experiment. An analogous influence of heat occurs in HALL'S phenomenon. The intensity of the magnetic fields used varied up to 9,000 C.-G.-S. lines per square centimetre. M. LEDUC finds that, for temperatures between 0°C. and 45°C., the alteration produced by imposing a field of 7,000 lines diminishes by 1·09 per cent. for every degree centigrade increase in temperature.

THE Deptford station has been the subject of many adverse comments, but it has remained for the *City Leader* to prove, with all the precision of a geometrical demonstration, that the scheme is hopeless. "It is a law of electrostatics," says the *City Leader*, "that the resistance to an electric current is proportionate to the length of the conductor and inversely proportionate to its transverse section. The conductor employed by the London company to bring current from Deptford is described as a hollow tube. If that is so, there can be no compensation of transverse section as a set-off to the tremendous resistance of the length of the cable." The short-circuit (*sic*) system of the Metropolitan company is, according to our contemporary, the solution of the problem.

An Electrical Inspector for Dublin.—The Corporation has decided to appoint an electrical inspector at £200 a year.

Croydon.—The Corporation has decided to oppose the Order promoted by the South of England House-to-House Electricity Company.

Northampton.—The Town Council has given formal consent to the Provisional Order of the Northampton Electric Light Company.

Ozokerite.—During 1889, the product of ozokerite from the Utah mines was approximately 130,000lb., as compared with 65,000lb. in 1888.

Obituary.—The death of Mr. Alfred Cowles, the inventor of the Cowles electric furnace for the production of aluminium, is announced from Chicago.

Hornsey Local Board.—At the last meeting of this Board it was decided to oppose the Order promoted by the House-to-House Electric Light Supply Company.

The French Atlantic Cable.—The cable steamer "Mackay Bennett" has successfully completed the repairs to the English-Brest section of the French Atlantic cable.

Electric Traction in Holland.—The first electric tramway in Holland will be opened in March next. It runs from the Hague to Scheveningen, a distance of about four miles.

Southport.—The Gas Committee of the Southport Corporation have refused an application for permission to run overhead electric light wires over certain streets in the centre of the town.

Electro-Therapeutics.—A series of articles by Dr. Arthur Harries and Mr. H. Newman Lawrence, entitled "Practical Lessons in Electro-Therapeutics," is being published in the *Nursing Record*.

Heriot-Watt College, Edinburgh.—At a meeting held on Monday of George Heriot's trustees, Dr. R. M. Walmsley, of London, was appointed Professor of Electrical Engineering in this College.

Edinburgh Exhibition.—Messrs. Galloways have been requested by the Executive Council of the Exhibition to provide the steam required, and have agreed to supply five "Galloway" boilers, 30ft. by 8ft., for that purpose.

The Llanerch Pit.—While we sincerely deplore the awful loss of life which occurred at the recent explosion in this pit, we are glad to learn that Messrs. Immisch and Co.'s 30 horse-power pumping and hauling plant was quite uninjured.

The Electric Lighting of the British Museum.—The grand total of visitors to the Museum in the first six working days of its evening opening was 12,228, or nearly one-half as many as visited the Museum during the whole of the preceding month of January.

St. George's (Hanover-square) Vestry.—At the last meeting of this vestry the recommendation of the Electric Lighting Committee that the vestry should give their consent to the application of the Chelsea Electricity Supply Company for a Provisional Order and a licence, was adopted.

Wimbledon Local Board.—At the last meeting of the Board the Electric Light Committee reported that Mr. Preece had laid before them estimates of the cost of lighting the town with electricity, which estimates had been ordered to be printed, and placed in the hands of the members.

Digitized by Google

Tunbridge Wells.—At the last meeting of the Town Council the Electric Lighting Committee presented a report on the Provisional Order promoted by the South of England House-to-House Electricity Company, and objections which they had lodged with the Board of Trade against it. The report was adopted.

South African Telegraphy.—The Cape Government has authorised the construction of a direct line from Potchefstroom to Vredefort over Venterskroom. Eight wires will be added to the line from Potchefstroom to Klerksdorp, and four wires to the line from Klerksdorp *viâ* Wolmaranstad, Bloemkof, and Christiana, to Kimberley.

Fulham Vestry.—This Vestry has decided to oppose the Provisional Orders of the House-to-House Company and the Brush Electrical Engineering Corporation on the ground that there in not at present sufficient demand for the light to justify the expenditure of capital and the disturbance of the streets which would result from approval.

The Transformer Patents in Austria-Hungary.—The action brought by Max Deri, engineer to Messrs. Ganz and Co., of Budapest, for the revocation of the Gaulard-Gibbs patent for the distribution of electricity by means of transformers, has been successful, and their patent of December 27th, 1882, has been annulled on the ground of anticipation and too broad a claim.

The Value of the Ohm.—M. Wuilleumier has recently conducted a series of experiments, by M. Lippmann's method, to determine the true value of the ohm. He found that it was equal to the resistance of a column of mercury at 0°C., 1 square mm. cross section, and 106·27 centimetres high. This value differs by 1/5000th from the values adopted in 1881 and 1884.

Actino-Electric Phenomena.—J. Borgmann has recently shown by illuminating the anode through a rotating perforated disc and observing the current by means of a telephone, that the action of the ultra-violet rays is not instantaneous but requires an appreciable time. In fact, the telephone clearly indicated a current when the disc was at rest and the anode was illuminated, but the sound ceased when the disc revolved.

Industrial Enterprise in Hungary.—In the Lower House of the Hungarian Diet on Saturday last, the Minister of Commerce, M. Baross, presented a Bill, with the object of fostering home industries. It provides that factories which make articles not hitherto produced in Hungary, and many already existing concerns which the Minister specified, including machine and electrical works, shall enjoy exemption from income-tax, besides other advantages.

Electrostatic Phenomena in Ceresin Works.—In a stearin and ceresin works in Italy it was recently discovered that ceresin presents some remarkable electrical phenomena. The electric light went out suddenly one evening, and it was found that some small casks of white hard ceresin, which had been set aside to cool, and were then just at the solidifying point, gave off pale sparks at the slightest movement, and gave the hand a shock at 1·6in. distance. These phenomena lasted half an hour.

Oyonnax.—MM. Cuenod-Sautter, of Geneva, are erecting a hydro-electric generating station close to a large waterfall, eight kilometres from Oyonnax (Ain). The generating plant will at first consist only of two 150 horse-power dynamos. As the district is a manufacturing one, the current will be used as much for motive power as for light. This installation is expected to attain some importance in the near future, and arrangements are being made for an ultimate capacity of 1,200 horse-power.

Weybridge.—At a recent meeting of the vestry a report by Major Cardew was read, which stated that the present overhead wiring was not in accordance with the Board's regulations for high-pressure service as regards the insulating covering. To comply with these regulations would, it was stated on behalf of the contractors, involve an expenditure of £400 to £500. After some discussion, it was decided to make arrangements for placing the conductors underground, as soon as the experimental lighting had been fairly tried.

The Société Générale des Téléphones.—The Directors of this Company in their last report to the shareholders state that the telephone manufacturing business of the Company has increased so much of late that it has been found necessary to greatly extend the Paris factory. The Directors also announce that it is their intention to add a submarine cable department to their factory at Bezons. One half (59 miles) of the cable between Martinique and Guadeloupe, recently laid by the Compagnie Française des Télégraphes Sous-Marins, came from the Bezons works.

Proposed Electric Railway between St. Petersburg and Archangel.—*La Lumière Electrique* reports that a scheme is on foot in Russia for connecting Archangel and St Petersburg by an electric railway. The estimated cost of the proposed line, including rolling stock, is £4,150 per mile, or 30 per cent. less than that of an ordinary railway. As the distance between Archangel and St. Petersburg is considerably over 500 miles as the crow flies, the Archangel merchants, who are said to have originated this project, must possess a remarkable degree of enterprise.

The Institution of Electrical Engineers.—The students of the Institution met last Friday to discuss Mr. Mordey's Paper on "Alternate Current Working," Mr. W. B. Esson in the chair. The meeting first confirmed the election of the following committee for 1890:—Messrs. A. E. Childs, S. L. Horn, J. A. Muir, G. Müller, G. H. Thornton, H. Walker, D. S. Barton, hon. sec. Mr. Müller then made some opening remarks on the above Paper, and the discussion was continued by the Chairman, Messrs. Wightman, Walker, Horn, and Raphael. A vote of thanks to the Chairman terminated the proceedings.

Colonial Telegraphic Statistics.—

Total Mileage of Telegraph Lines Open.

	1879.	1888.	Increase.
India	17,971	31,894	13,923
Ceylon	—	715	715
Australasia	26,974	38,846	11,872
Cape of Good Hope	2,713	4,339	1,626
Natal	409	501	92
Canada	returns defective	29,245	—
West Indies	not stated	1,473	—
Mauritius	78	117	39
Totals	48,245	97,130	38,267

The Surgical Electric Lamp.—In a short article on "The History and Uses of the Protected Surgical Electric Lamp," in a recent number of the *British Medical Journal*, Mr. N. Stevenson states that in 1883 he designed an electric light for dental work, but the difficulty in getting the lamps and unsatisfactory working of the batteries made him abandon the use of it. Now, however, that better lamps can be easily obtained and that the batteries are immensely superior to the old ones, he had taken to them again and adapted them to other surgical purposes. "I cannot," says Mr. Stevenson in conclusion, "estimate the practical value to others of these instruments, but I think there must be many who will find them, as I do, of great service."

Telegraphic Wire Boxes and Gas Leakages.—The postal authorities at Barnsley have been annoyed for some little time by escapes of gas in the "flush" boxes which contain the underground telegraphic wires; and the *employés* of the Barnsley Gas Company have been endeavouring to discover the causes of the escapes, and have tested the boxes frequently. On Thursday last week one of the men tried a box by striking a match. Immediately a loud explosion occurred. The man had a remarkable escape, being injured in the face by a piece of stone. The shock was felt a considerable distance away, whilst it blew the covering of the box (weighing about 1 cwt.) into the air, and it fell at a distance of fully fifty yards.

Electrical Phenomena in Nature.—Electrical phenomena in nature formed the subject of an interesting lecture delivered at the London Institution on Monday afternoon by Mr. Shelford Bidwell, who dealt with the question chiefly as it related to thunderstorms. Mr. Bidwell said that the lightning flash made familiar by artists was not known to science, and was about as truthful as most attempts to depict horses in motion. Referring

Digitized by Google

to the controversy initiated by Dr. Lodge as to the value of electrical conductors, the lecturer said that in all cases of "steady strain" a lightning conductor was of great service, yet it could not always be relied upon as affording immunity from risk. As to the danger to life from lightning, one was almost as likely to be hanged for murder as to be killed by lightning.

St. Pancras Vestry.—On Wednesday the St. Pancras Vestry decided, in accordance with a recommendation of the Electricity Committee, to pay Dr. Hopkinson, F.R.S., 100 guineas in consideration of the Committee and Prof. Robinson being at liberty to consult him from time to time on the details of the installation and preparation of plans, specifications, and estimates for carrying out the same up to the time of advertising for tenders. Messrs. Bircham and Co., Parliamentary agents to the Metropolitan Electric Lighting Company, intimated the desire of this Company to supply the south end of Tottenham Court-road, and asked for the Vestry's authority to lay their mains across that part of St. Pancras. The request was not complied with, as the Committee "considered it undesirable to allow a Company to have any powers in the parish."

A Carbonic Oxide Indicator.—An apparatus for indicating the presence of carbonic oxide gas in the atmosphere has been perfected by a M. Rasine. Its action depends on the property of spongy platinum to absorb carbonic oxide with evolution of sensible heat. Two metallic plates are placed vertically over each other, which when touching close an electric circuit. The upper plate is suspended from a hook by means of an easily combustible thread. This thread is wrapped in muslin, containing a little cotton powder dusted over with spongy platinum. If this arrangement is exposed in an atmosphere containing carbonic oxide, the spongy platinum will absorb it, and set fire to the cotton, which will in turn burn the thread, and so cause the electrical contacts to complete the circuit, and ring a bell. It remains to be seen whether the spongy platinum would always remain good for use in this way, and also that the same effect would not be produced by any other gas to which the apparatus would be exposed.

The Municipal Rapid Transit Problem in London.—Speaking recently in support of the Central London Railway scheme at the City Tradesmen's Club, Mr. William Morris (of Ashurst, Morris, Crisp and Co., solicitors for the Bill), gave some interesting figures with regard to the increase in the number of passengers carried by the various companies within the metropolis. In the year 1864 the number of passengers carried by the London General Omnibus Company, the Metropolitan Railway, the District Railway, and the tramways combined was 53,000,000; while last year the London General Omnibus Company carried about 80,000,000, the Metropolitan Railway and the District Company combined about 120,000,000, and the tramways 130,000,000: a total of 330,000,000, or an increase of over 600 per cent. During the same period the population of the metropolis had only increased 40 per cent. Those four companies carried every person in the population 90 times in the year, while in New York every person in the population was carried something like 200 times.

Bradford.—In moving the adoption of the proceedings of the Gas and Electricity Supply Committee at the last meeting of the Corporation, Alderman Priestman, referring to the electric light, said that the expenditure to the end of the year was £26,013, but as the works were not in operation till November 1st, there had only been two months in which electricity was supplied, and the income during that time was £580. Until the works had been in operation a few months longer, a definite idea could not be formed as to the financial result; but he had every confidence in the success of the electric works, and the Town Clerk had had an offer from a gentleman to give the Corporation a profit of £10,000 if they would put the works into the market. Replying to Mr. Galloway, who expressed a fear that the electric works would not prove profitable, he added that he had no doubt that next year he would be able to give a satisfactory statement, although he did not expect he would be able to show a profit till the end of two years. At the same time, he pointed out that the main object of the Corporation in undertaking to supply electricity was to keep out other persons who were offering to provide the electric light for towns.

The Jacobus Closed Circuit Burglar Alarm.—In a recent number of the *Stevens Indicator*, Prof. W. S. Jacobus, of the Stevens Institute of Technology, describes a new form of closed circuit burglar alarm. The trouble experienced in connection with a closed circuit system with gravity batteries, led to the adoption of what is nothing more than a high resistance galvanometer furnished with a means of making and breaking a powerful supplementary circuit containing the alarm bell, the main circuit current being provided by a single Leclanché cell. The resistance of the galvanometer is about 2,600 ohms, so that this single cell may be expected to run three or four years without renewal. The supplementary circuit is actuated as follows. On the top of the needle at the centre is attached a bent platinum wire, dipping into a trough of mercury. Underneath the needle at some distance from its centre there is a projecting platinum stud, and underneath this again there is a nearly complete circular groove filled with mercury. Each mercury trough is in connection with one end of the supplementary circuit. When the main current is flowing through the coil of the galvanometer the projecting platinum stud is situated midway between the two ends of the nearly complete circular groove. When the current ceases the needle swings over, the platinum stud enters the mercury, completing the supplementary circuit and ringing the alarm bell.

The Conductivity of Coloured Flames.—Several attempts have been made to measure the conductivity of flames, and especially of those containing the vapour of metallic salts. These investigations have up to the present only furnished contradictory results. To obtain coloured flames under definite conditions Wiedemann and Ebert have, by means of a spray, impregnated the air feeding a Bunsen burner with a saline solution of suitable density, and have thus been in a position to know exactly how many milligrammes of metallic vapour were contained at any moment in a unit volume of flame. The character of an electric discharge is, of course, considerably modified by interposing a flame in its path: the discharges become more rapid and the sound given out by a telephone is increased. On the introduction of metallic vapours into the flame, a still further change takes place, the nature of which essentially depends on the nature of the metal introduced. With potassium the telephone is reduced to silence, the discharge becoming almost continuous. Sodium, even in considerable quantities, produces a far smaller effect. In both instances the discharge remains disruptive in character, and there can, therefore, be no question of the flame being electrically conducting. Potassium and magnesium have peculiarly strong effects, due doubtless to the ultra-violet rays which they emit in abundance, and the effect of which when they fall upon the negative electrode is to lower the difference of potential necessary to cause a discharge.

Frosting Incandescent Lamp Bulbs.—All the portable incandescent lamps used on the Pullman special trains have frosted or "ground" bulbs, prepared in the glass department of the Pullman Car Works by suspending the glass bulb in a solution of so called "white acid" till the proper depth of glass is removed or dissolved. Mr. A. H. Bauer has suggested the employment of the Planté process for securing delicate tracings on the lamps, and, in fact, on all the glass so treated, namely, to cover the plate with a saturated solution of nitrate of potassium (pure saltpetre), and trace the design thereon with a finely-pointed platinum pencil connected to one pole of a storage battery, the other pole being connected to the plate. The white acid can be prepared by slowly mixing equal parts of hydrofluoric acid and soft water in a lead or rubber vessel, and allowing same to stand till cool. (Add the acid to the water, not the reverse.) Then carefully drop small particles of carbonate of ammonia into the solution till all foaming ceases, when the solution is ready for use. In using the preparation it is well to preserve the fingers from ill effects by anointing them with vaseline or some similar preparation. Another method of securing a temporary frosting on a globe, and one more simple and easy of operation, is to make a saturated solution of sulphate of magnesia (Epsom salts) in clear water; strain the solution to remove any minute particles of dirt, and then dip the bulbs therein, drying and dipping again, repeating the

Digitized by Google

process two or three times till the desired effect is secured. But bulbs thus coated can only be used on one or two occasions, and must be handled with extreme care. The frosting can be entirely removed by a moment's washing, thus leaving the glass clear for treatment with tints or otherwise.

Brighton.—On Friday evening last a public meeting was held for the purpose of passing a resolution to the effect that the proposed municipal electric lighting scheme was an experimental one, and must necessitate the expenditure of a much larger sum than £30,000. There was a very large attendance. Councillor Ballard presided, and amongst those present on the platform were Mr. Killingworth Hedges, Mr. F. Ince, Mr. Mark Parker, of Rochester, and Mr. W. T. Taylor, of Harrow-on-the-Hill. The chairman said that the whole proceedings in connection with this electric lighting scheme had been characterised by undue haste, and the vote in favour of it had only been carried owing to the fact that many members had given their votes under the erroneous impression that a private company would have a monopoly and practically unlimited powers of disturbing the streets. Electricity was, in his opinion, a luxury, and should not be supplied at the ratepayers' expense. Mr. Killingworth Hedges criticised Mr. Shoolbred's report, especially from the financial point of view, and asserted that it would be impossible to make both ends meet if only 6d. a unit was charged. He then detailed the advantages of the high-tension alternate-current system, and said that perhaps the best testimony in its favour was its rapid progress in America and its adoption at Paris and Rome. Mr. F. Ince laid great emphasis on the inevitable expense attending the multiplication of generating centres, and said that according to Mr. Shoolbred's plan Brighton would require from 37 to 40 stations. He advocated one large station and 10,000 light dynamos. The resolution was subsequently carried with the addition of an amendment requesting the Mayor to call a public meeting to consider the question.

Mr. Edison and his Work.—In the February number of *Harper's Magazine* there is an article by Mr. George Parsons Lathrop, a well known *littérateur*, giving the gist of several conversations he has had from time to time with Mr. Edison. One point may be noted in connection with the incandescent lamp—in regard to the immense amount of work done by the inventor before he obtained what he considered satisfactory results in connection with the lamp and its filament. Mr. Edison stated that from first to last he had constructed some 3,000 different theories in connection with the electric light, each one of them reasonable, and apparently likely to be true; yet in only two cases did his experiments prove the truth of his theory. Mr. Edison stated further that his work is still going on with the lamp, and that he had now reached a point where he could maintain fully 15 lamps to the horse-power. The article does not mention the fact, but it may be noted that at the present time Mr. Edison is actively engaged with his magnetic ore separator, with which some very good results have lately been obtained. He is also very busy with the development of some new ideas in connection with electric traction, his aim being to perfect a method by which electric cars can be run in cities with direct supply, but without the objectionable features of the overhead wire system and of the conduit system. It is believed that Mr. Edison himself will take an active part in the further development of the Sprague Company, both as regards electric traction and as regards stationary motor work. Another matter to which Mr. Edison is giving some of his attention, it is said, is the equipment of the new Edison stations in this city, including one which, if report be true, will be equipped with large Edison multipolar generators of new design, coupled direct to compound condensing engines.

The Mehner Dry Cell.—An improved dry cell has recently been brought out by Dr. C. H. Mehner, of Berlin. In dry cells it is usual to employ as a vehicle for the exciting liquid a neutral material which absorbs the liquid excitant and forms therewith a stiff paste. The materials commonly employed for this purpose are sponge, sawdust, gypsum, gelatine, and the like. It is evident that the introduction of these inactive materials is prejudicial to the action of the cell, as they form an encumbrance which, apart from its purely mechanical action, in no way promotes, but on the contrary tends to diminish, the effective working of the battery. In order to dispense with this inactive matter, Dr. Mehner imparts the required consistency to the exciting agent by preparing it as follows:—The exciting salts, consisting of suitable chlorides of the alkalies, are mixed with a "mineral gelatine." This gelatine retains the salts in a paste, and, possessing exciting properties in itself, also acts as an exciting agent. The "mineral gelatine" consists of crystallised hydrated basic chloride of magnesium, which is formed by the addition of magnesia to a highly supersaturated and concentrated solution of magnesium chloride. If a suitable quantity of the solution of magnesium chloride is added to the oxide of magnesia, for example, in the first instance, a liquid product of a creamy consistency results, at first gradually gelatinising and ultimately acquiring a pasty consistency. The degree of stiffness of the final product can be readily controlled by suitably regulating the addition of chloride solution. Dr. Mehner utilises this property of oxy-chloride of magnesium in the preparation of his dry cell. He stirs the exciting salt with a solution of chloride of magnesium and calcined magnesia until he obtains a liquid of about the thickness of cream, which he pours into the cell. In the course of a few days the liquid changes to a stiff pulp, and the cell can then be closed. The "mineral gelatine" being in itself a substance capable of producing an exciting action in a galvanic cell, the employment of an inactive material is thus entirely obviated.

Effect of a Thunderstorm upon an Underground Endless Rope at Kibblesworth Colliery.—The December number of the *Journal* of the British Society of Mining Students contains an interesting account of a curious electrical phenomenon which was observed at the Kibblesworth Colliery, on July 23rd, during a sharp thunderstorm. The phenomenon occurred in connection with a self-acting endless rope 1,900 yards long, situated in what is known as the Hutton Seam 60 fathoms below the surface. The rope affected by the storm was not connected with any other rope: it was of 2½in. iron and had tubs attached to it at intervals of 25 yards. During the thunderstorm the rope became suddenly charged with electricity. The lad "braking" said that at about 2.15 p.m.: he felt "strange sensations" in his right hand, which was on the brake handle, and also in his legs. The shocks were intermittent, and only slight at first, so that he was able to touch the brake or rope when necessary. In a few minutes, however, the rope gradually slackened its speed, and then stopped. This stoppage was apparently accounted for by a full tub being found off the way. The waggon-way man, who had charge of the ropes, lifted this tub on to the rails with the assistance of the brake lad: they both received several shocks whilst handling the tub, they then immediately went into the brake wheel expecting that the rope would go away on lifting the brake. The rope, however, would not move. They then called another man and some lads and "swayed" on it for nearly a quarter of an hour. It then moved a yard only and stopped again. Subsequently another full tub was found "ended up" on the rails. They replaced this tub and again felt electric shocks on taking hold of the tub. After again working at the rope for about a quarter of an hour with no result, they all desisted, and then whilst considering what to try next, within five minutes, when no one was touching the rope, it gently moved away as if nothing had been wrong, and continued to run in the ordinary way, without giving any more trouble, for the remainder of the day. The time was 3:45 p.m. when the rope began to run again, and by this time the thunderstorm was also about over, and no more shocks were received from either rope or tubs. Altogether 11 men and boys received shocks. Electric bells are used on this road for signalling, in addition to the telephone: they all worked correctly during the electrical disturbance. The endless rope hauling to the shaft was not in any way affected. No lightning was seen by any one in the pit. This seems to show that the electric current did not descend by the shaft, but more probably was produced in the rope by induction from the earth on its becoming highly charged with electricity at the commencement of the thunderstorm.

Digitized by Google

ELECTRICITY AND THE LAW.

BY A. C. CURTIS HAYWARD, B.A.

No one who has followed the course of events during the past twelve months, or has glanced at the list of applications to the Board of Trade for electric lighting powers recently printed in these columns, can fail to recognise the great and increasing importance of the attitude of the law towards electrical industry. No apology need therefore be made for referring to this subject at some length.

We shall not discuss the vexed question whether electricians of to-day or the general public are in any respects the better for the Act of 1882, which resolves itself principally into the inquiry whether it was desirable at that date to snuff out the flame of perhaps too sanguine speculation. We have to deal with the law as we find it now, and certainly an examination of this Act does not lead to the opinion that it is anything to be proud of as a piece of legislation. So long as the famous 27th Section stood, it mattered very little what else there was or was not in the Act; but directly this stumbling block had been removed, and 42 years were substituted for 21, within which capitalists might reap the reward of their expenditure, the rest of the Act at once demanded attention. It then became apparent what a defective and incongruous piece of patchwork had been hastily put together. The primary object being, as was supposed, to enable undertakers to break up streets for laying their conductors, it is remarkable that no such power is to be found within the four corners of the Act. Certain things are stated to be forbidden or permitted in case of streets being broken up, but the power itself and the general regulations under which it may be exercised have to be sought for in certain sections of the Gas Works Clauses Acts, which are incorporated and adapted for the purpose by the rough-and-ready direction "for 'gas' read 'electricity.'" Anything seems at that date to have been thought good enough for the new infant "electricity," and it must needs make shift with old clothes, principally belonging to its elder brother "gas," until new clothes could be provided for it—which, truth to tell, no one knew exactly how to make. In the meantime fresh light was thrown upon the nature of electricity by a Parliamentary enactment, which provided, amongst other things, "for the washings and waste liquids to arise in the course of its manufacture." If the use of "scrubbers" had also been prescribed, this would doubtless have been considered no more than was proper for the infant's health.

To the Board of Trade was entrusted the duty of providing the new garments, and such were the materials that department had to work upon when the wave of enterprise which had been beaten back in 1882 again advanced in 1889, and for the first time serious business had to be dealt with under the Electric Lighting Acts. A drastic remedy was clearly necessary, and the Board wisely made no attempt to patch up the rags of existing legislation, but by the issue of their model form of Provisional Order practically enacted an entirely new law, which to a great extent supersedes the Acts previously in force. This was so far good, and was effective as regards Provisional Orders, which, being confirmed by Parliament, become statutory enactments. But how does the case stand with respect to Licences, which the Board of Trade desired should be subject to the same law as Provisional Orders? The Act of 1882 gives prospective sanction to regulations on various subjects to be inserted in Licences by the Board of Trade, who have very wide powers in this respect. These powers are not, however, wide enough to admit provisions which are inconsistent with the Acts, or which deal with subjects not expressly committed to the discretion of the Board. Consequently, clauses about which no questions can arise, if sanctioned by the confirming Act that gives validity to a Provisional Order, might be *ultra vires* if resting on the mere authority of a Board of Trade Licence.

An instance of this difficulty was noticed a few months ago in these columns in connection with a Licence for Newcastle. The particular case in question is not, that we are aware of, pointed out in any legal treatise, and the right of its discovery appears, therefore, to be the exclusive property of the Town Clerk of that city. The Act of 1882 authorises the Board of Trade to impose penalties in various cases, and such penalties are provided for in the Model Order, which goes on to say that these may be recovered in a summary manner before a Court of Summary Jurisdiction. Unfortunately, this addition is not authorised by the Act, and needs confirmation by Parliament; so that defaulting licencees, although they might suffer under the stigma of being legally liable to penalties, must go scot-free in the absence of a Court empowered to order payment. The validity of some other clauses of the Model Order must also be open to doubt when applied to Licences, so that for this reason, if for no other, the Electric Lighting Acts calls for some immediate amendment.

Other reasons are not, however, wanting. The Model Order is a very lengthy document, nearly the whole of which is occupied with matters of general application, which ought not to be repeated in every Licence and Provisional Order, thus entailing useless labour upon everybody concerned. It has already been announced that pressure of electric lighting business has necessitated some changes in the staff of the Board of Trade. We suggest one contribution towards relieving the labour of that Department: it is that the law should speedily be placed on a sounder basis. The infant has now grown to years of discretion, and is big enough to be relieved from the temporary assistance of Acts framed for totally different purposes. In a word, if a new Act is to be passed, it should not be a mere tinkering at the present defective structure. The two Electric Lighting Acts should be repealed, such of their sections as are not obsolete being re-enacted in an Electrical Works Clauses Act, which could deal comprehensively with the whole subject in a businesslike manner, and avoid the necessity for the same provisions being re-enacted over and over again in every Provisional Order.

There is further reason for putting forward this suggestion at the present time. Nothing but a general Act can remove the inconvenience and difficulties likely to arise from the anomalous position occupied by the London County Council under the Metropolitan Orders granted in 1889. It is very desirable that the serious mistake which has been committed in this respect should be rectified before its effects have become stereotyped. We use the term "anomalous" advisedly, because there is nothing in the previous state of the law which gave any countenance to the position claimed by the Council, and which has to some extent been conceded to their demands. It is true that the Provisional Orders which make these concessions have, as a matter of fact, been confirmed by Parliament, but this does not justify the inference that the very important departure from the policy of the Electric Lighting Acts thereby inaugurated has been deliberately adopted by the Legislature. It is well known that some important questions were allowed to slide by the companies directly interested, rather than, by raising objections at a late period of last session, run the risk of having their Orders shelved for another year. The companies may also have secretly solaced themselves with the belief that certain objectionable clauses would be found unworkable, and so die a natural death without being attacked. Had such an attack been made, we cannot believe that these mischievous provisions would have become law.

We have already pointed out that, in framing the Electric Lighting Act of 1882, Parliament was either unable or unwilling to deal effectively with the whole subject, and preferred to throw upon the Board of Trade all the responsibility of filling in the details to a mere outline hastily sketched by that Act, subject to certain reservations in favour of the Local Authority of each district. It is not our present purpose to quarrel with this policy, but merely to affirm that responsibility and control should remain in the hands to which the Legislature committed it. The very important functions to be performed by "electric inspectors" as regards testing mains, &c., should, we think, have been exercised only under the direct control of the Board of Trade; but in any case such control should not have been committed to the London County Council. This objection is accentuated by the expectant attitude of that somewhat over-zealous body, who seem to anticipate their acquirement of other powers from the Board of Trade. We have had only too

Digitized by Google

many recent instances of the audacious ignorance or wilful misrepresentation of those who aspire to guide public opinion on electrical matters in the daily press or in contributions to monthly reviews. It must therefore be a subject of anxiety to those interested in the progress of electric lighting, that while the public mind is thus kept in a condition of unstable equilibrium, the first step should have been taken towards allowing interference in technical matters by a popular assembly, which is without experience and without machinery such as is possessed by the Board of Trade, and which must always be exposed to the influence of popular panic or unscrupulous agitation. Moreover, there is the special objection to the London County Council that it has no official status under the Electric Lighting Acts, except as regards such parts of the Metropolis as the late Metropolitan Board of Works were authorised to light, and for which it has now become the Local Authority. As regards the far larger area which is under the jurisdiction of parochial authorities, the Council is a body altogether unknown to the Acts, and its status under the Model Order is therefore the gratuitous creation of the Board of Trade. If, as is surmised by Major Marindin in his report, the Council should ultimately become the central authority for the purpose of lighting and managing the streets of the whole Metropolis, it will no doubt also become the Local Authority, as defined by the Act, for the same area, and then will be time enough to consider what, if any, new functions it shall exercise in connection with electric lighting. But in the meantime the grant of any special powers to the Council is merely introducing a system of dual government which, we are always being told, is just what London does not want.

As matters now stand, the result is certainly somewhat confusing, and anyone reading the Model Order must be a good deal puzzled by a kind of kaleidoscope effect produced by the frequent changes between the names "Local Authority" and "County Council," of which the guiding principle is not always easy to deduce. For instance, with the object presumably of preserving the strict impartiality of the "Electric Inspector," he is parcelled out with great care between these two authorities and the Board of Trade. He is to be appointed by the London County Council, who are also to fix and pay his remuneration; his fees for testing mains are to be fixed by the Local Authority, subject to the approval of the Board of Trade. His fees for certifying meters are, however, to be fixed, not by the Local Authority, but by the County Council, who may also require him to hand over all fees he may receive to the county rate. Finally, if the Council do not appoint an Inspector, the Board of Trade may do so. We might suggest one addition to all this, namely, that if any of the parties should not be satisfied with their share in the electric Inspector, he shall be re-alloted by an arbitrator.

There is another point which has already provoked discussion both in these pages and elsewhere, but since it is somewhat of a burning question we may be pardoned for mentioning it again. The Board of Trade, by No. 2 of their rules relating to applications for Provisional Orders, &c., have laid down that they "will give preference to the application of the Local Authority of the district in every case where, in the opinion of the Board of Trade, *no special circumstances exist which render such a preference inexpedient.*" Now, it might be thought unfair to say that this rule—which, we are bound to admit, is not inconsistent with the spirit of the Electric Lighting Acts—should be wholly repealed, because certain Local Authorities have made use of the advantage it accords in a manner which cannot have been intended by its framers. We have as yet no experience as to what circumstances will be deemed by the Board of Trade so special as to forfeit the right of preference, and our remarks may therefore be only anticipating some effectual remedy which has already been determined on. We certainly do hope that there is stored up somewhere in the official mind an appropriate Nemesis ready to descend at the right moment upon those who have been guilty of abusing their privileges. We venture further to hope that the form of this Nemesis will also shortly be made public, so that it may be duly digested before the 1st July comes round again. In the meantime we trust it will not be thought disrespectful if we express an opinion as to the construction of a rule whose administration is solely within the province of the Board of Trade. Personally we should not regret if a radical amendment were adopted, but for the present we content ourselves with an interpretation of the rule as it stands. We should ourselves think *such a preference inexpedient* in any case where the Local Authority applying for a Provisional Order had on a former occasion been instrumental in stifling an independent application, without any *bonâ fide* intention of itself obtaining lighting powers. We should find the Local Authority guilty of this act of infanticide if it had—say within two years previously—passed a resolution, in the manner prescribed by the Act of 1882, that lighting powers should be applied for, and had failed to make such application in the following month of November; or had withdrawn its application without being able to satisfy the Board of Trade, after hearing anything alleged to the contrary by an opposing applicant, that such failure or withdrawal was due to good and sufficient causes not existing at the date of the resolution. We need hardly say that we should not consider a sudden aversion to electric light, or a discovery that it would be detrimental to the Corporation gas works, a good or sufficient cause. We further suggest that it might be a useful addition to the rule to make it one of the conditions of preference that the Local Authority should have lodged with its memorial of application a statutory declaration made in such form and manner as the Board of Trade should prescribe, giving assurances of a *bonâ fide* intention to prosecute the application. There remains, of course, the possibility of a Local Authority obtaining a Provisional Order and making no effective use of it. This is to some extent enhanced by the fact that, judging by the Order granted last year to the Swansea Corporation, no security will be required by the Board of Trade from Local Authorities, such as other undertakers are required to give for performance of their obligations as regards laying mains. In such a case, however, the Board of Trade would probably not be slow in granting powers to a competitor.

It would not fall within our limits to add more at present as to defects in the law of electric lighting, but we hope enough has been said to make out a case for its reconsideration at an early date.

UNDERGROUND MAINS.

BY G. L. ADDENBROOKE.

V.

(Continued from page 344.)

HOUSE-TO-HOUSE COMPANY.

The best example of the underground system of conduits and mains used by this company is furnished by the arrangements adopted in their exceedingly neat and well-arranged alternating-current station at West Brompton. This station has now been working nearly a year, and has been extending its operations rapidly since the Board of Trade permits were issued in October last. The pressure used is 2,000 volts, and the underground system is on the same lines as that in the well-known pioneer installation at Eastbourne, which has worked so satisfactorily since its establishment.

The mains are all of indiarubber-covered wire, manufactured by the Indiarubber Company of Silvertown. The insulation is their highest class of vulcanised rubber, and this is protected by a double braiding saturated with compound. This is a class of cable which has proved its ability to confine a 2,000 volt current to the conductor, in several instances for long periods, in a perfectly efficient manner. The connections for customers are made by opening the cables and splicing in smaller wires, the place of opening being insulated again in the ordinary manner of making a first-class rubber joint. The largest sized cable at present in use is 19/17, and from this they range downwards to the small size used for connecting customers.

These cables are all laid in iron piping with a system of manholes and connecting boxes which have been specially designed for the work. The company find that they can draw as great a length as half a mile of cable in at once quite easily,

Digitized by Google

even round corners if necessary, by taking the precaution to station a man at each manhole to ease the cable, and to pass it round bends—there being, of course, a manhole at each place when the direction of the cable alters. The iron pipes which are used for protecting the cables are ordinary cast-iron socket pipes, and three sizes are employed—6in., 4in., and 3in., according to the probable number of mains which will ultimately pass through them. The company do not make it a point to exclude water, for holes are bored in what will be the lower part of each pipe, to allow water which may accumulate to drain off into the soil.

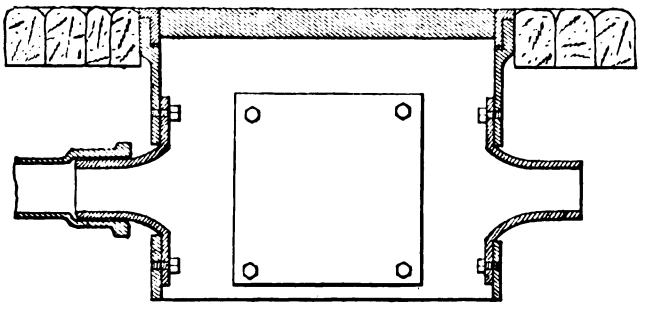


Fig. 13.—House-to-House System. Manhole.

On an average about every 70 yards, but naturally depending a good deal on the distance of the streets apart, there is placed a manhole. The construction of these is much the same as those employed by the General Post Office, and will readily be seen from the drawing (Fig. 13). First of all we have an iron frame about 3ft. long, 1ft. 6in. broad, and 2ft. deep: this has a deep double lip all round the top, while the bottom is open. In each of the four sides there is a large opening with bolt

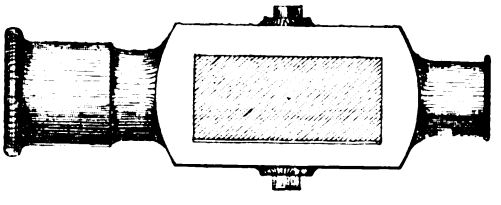


Fig. 14.—House-to-House System. Connecting Piece.

holes round it, to which cone-shaped pieces can be attached from the inside, as shown in the sketch. These cone pieces are made all the same size at the large end, but taper down to a smaller aperture at the other end, and this smaller end is made of three different sizes to fit the sockets of any of the different sized pipes used. These cone pieces are moreover very useful and valuable, as giving a smooth, curved surface when the mains enter and leave the pipes, so that they can be drawn in or out with great facility, and without coming in con-

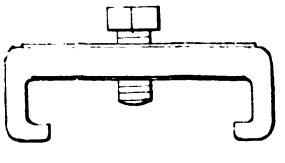


Fig. 15.—House-to-House System. Cast-Iron Clamp used in Connection with the Connecting Piece.

tact with any sharp or angular surface likely to abraid them. If any of these holes in the sides of the manholes are not required to be used, they are covered over with a flat plate placed on the inside. The covers of the manholes are made of a strong iron frame fitting into the deep groove in the top of the manhole frame, and the inside of the frame is filled up with concrete or wood blocks to correspond with the pavement or roadway where the manhole may be situated.

There is a further arrangement for making connections to customers, and in laying pipes this connecting piece is put in opposite every other party wall, so that each house is within quite easy reach of the mains. The exact form of this connecting piece will be best understood from Fig. 14, which almost explains itself. A short piece of pipe is cast with an oblong opening, the opening being about two-thirds of the total length of the pipe. The area of the pipe is somewhat enlarged, for the length of this opening which is finished off square at the top and provided with a flange along each side, while in each side of the box two holes are tapped to take 1½in. wrought-iron gas tubes, these tubes being used for carrying the branch leads into customers' houses. When not in use these holes are filled by screw plugs. A ribbed iron lid with a piece of felt underneath covers the opening in the top of the connecting piece, and it is kept in its place by a cast-iron clamp (Fig. 15) provided with claws at each end, which catch under the lips on each side of the top of the connecting piece. The clamp has a screw in the middle, which can be tightened up as required. Cast iron has been used for this clamp, so that in case of the screw becoming immovable from rust the clamp may be broken by a blow, which could not be done if it were of wrought iron.

London Electric Supply Corporation.

The Siemens concentric cables which this company are laying down, have already been described. It may be further noted that the company have had now for more than two years considerable lengths of indiarubber-covered and braided cable laid in iron pipes, ten cables in each pipe, chiefly under St. James's Park. These cables have stood a pressure of 2,400 volts for the whole time without giving any trouble.

The Ferranti concentric main has already been several times illustrated. It consists of two copper tubes, one inside the other, insulated between by a great number of layers of paper steeped in ozokerit. The outside copper tube is then further insulated and placed in an iron tube. The outer copper and iron tubes are drawn down on the insulation, which makes it very solid. Trial lengths of this tubing have successfully stood enormous voltages. A complete system of joints and junctions has been worked out, and much thought and care has been expended in all the details, which are of a very practical character. As a bold and original attempt to meet the requirements of an underground system of mains applicable to low as well as high pressures, the future working of these mains will naturally excite much interest.

Metropolitan Electric Supply Company.

This company have chiefly adopted a system of indiarubber cables in iron pipes, which up to the present are working extremely well.

St. James's and Pall Mall Electric Lighting Company.

This Company, which works on the low-tension three-wire system, has struck out a set of underground mains for itself of

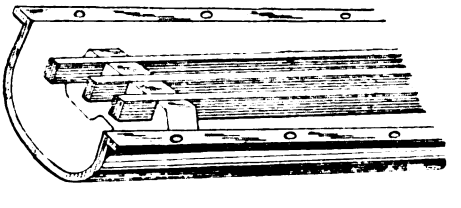


Fig. 16.—St. James's and Pall Mall System. Iron Culvert with Cover removed.

a distinct and original character. A partial description of their mains appeared in connection with an account of the station in a recent issue (*The Electrician*, January 24th), but for the sake of completeness, and because the system is really deserving of careful attention, a fuller account is included here. The type is that of bare copper strips carried on insulators in an iron culvert (Fig. 16). Fig. 17 shows a section of the culvert, which is made of cast iron in lengths of about 3ft. 6in. The lower portion is a trough, about 10in. broad and 6in. deep, with its edges turned over so as to form flanges, one on each side. A correspond-

Digitized by Google

ing and slightly arched cover forms the top of the trough, and is held in its place by a series of nails and bolts, the joints being packed with red lead and yarn. To connect these troughs together when laid, an iron piece of the same shape as the trough and about 5in. broad is fitted on outside, overlapping each trough equally, its flange just coming up under the flanges of the troughs. The joint is then run with lead. The converting piece being a little longer than the outside of the troughs allows a slight vertical or horizontal deviation to be made, so that the culvert can be carried round a moderate curve.

A similar piece of iron covers the joint between two lids, only in this instance a packing of yarn and red lead is used. Brick manholes, cement-lined, are arranged about every 100 feet, into which the culverts come. The manholes are always connected with the nearest drain, and wherever possible the culverts are laid so as to have a slope towards the manholes; where this is not possible the troughing is itself connected with the drains; a syphon box and hydrant is fitted, so that any

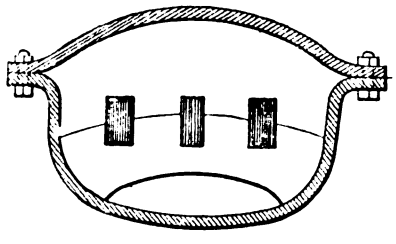


FIG. 17.—St. James's and Pall Mall System. Section of Culvert.

water which may collect can be pumped out, as is done in the case of gas mains. In some cases the manholes too have sumps when drains cannot be got at. The amount of water which collects in the culverts is found to be very little, and to cause no trouble. With the sumps experience soon shows which ones fill up soonest, so that it is easy to arrange for the water which accumulates in them, and which is never much, being pumped out. Across the culvert are placed at intervals of three yards glazed earthenware insulators of the form shown in Fig. 18. These insulators support the conductors, which are formed of bare copper strips, each 2in. wide by ·1in. thick, and it is found practicable to lay mains with a section up to 2 inches in each for the lead and return in the culvert of the size adopted. These strips are obtained in long lengths, and a sufficient number of them are run side by

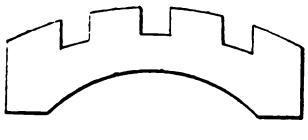


FIG. 18.—St. James's and Pall Mall System. Form of Insulator employed.

side to make up the required section of any feeder or main. When in their places they are flattened as far as possible by hand with a mallet, and held together at frequent intervals by a wire binding a big brass clip of the proper breadth. As already mentioned, the system is a three-wire one, and the ratio has been adopted of one-half for the section of the neutral wire as compared with the positive and negative mains. When the slips are in their places "jockey pieces" of earthenware are slipped across them from above, about every yard, to keep them exactly straight and in position, and then the cover is put on. It will be noticed that the strips employed are broader and thinner than those Mr. Crompton uses.

The mains are broken at each junction box, and connected across by a rigid bridge of less section than the mains, so that in case of accident it would melt before they were injured. By shunting the current this connecting piece can be unclamped and taken off, and the mains disconnected at any time when the current is on. As the system consists of a ring main running right round the district lighted, into which six large feeders convey current at intervals all round, almost any section of the mains or feeders can be cut out without interfering with the rest of the lighting, and repairs and alterations can be made with the minimum of interference with customers.

Connections to customers are made by drilling a hole in the culvert, and screwing into it gas tubing, through which the current is conveyed to the customer by the best class of vulcanised indiarubber cable, which is lapped round and soldered to the mains, the other end terminating at the meter. The Aron meter is used, and all customers are supplied on its indication: it is found to work very satisfactorily.

Current has now been supplied through these mains for 10 months without any stoppage or failure, and although the system has come in for a good deal of criticism, it appears to be thoroughly justifying itself by results. At the same time it is both cheap and easily laid.

(To be concluded.)

REVIEWS.

Medical Electricity and Massage. By H. NEWMAN LAWRENCE, A.I.E.E. (London: George Gill & Sons.)

As Managing Director of the Institute of Medical Electricity, Mr. Newman Lawrence enjoys exceptional opportunities of obtaining practical experience, and of keeping accurate records of the complicated phenomena associated with the application of electricity to the human body. We would therefore express the hope, that this little volume is but a sample of better and more scientific work.

The book "aims at supplying useful data and hints for nurses," for whom it is intended to serve as "a pocket companion." The first few pages are devoted to definitions of the technical terms most commonly used by electricians. The terms selected appear to be taken somewhat at haphazard, but the definitions themselves are concise, and, as far as they go, accurate. We are particularly glad to see that Mr. Lawrence is emphatic as to the importance of accurate "dosage." The absurdity of ordering electricity "by the cell," is a manifest and unfortunately too common an error, but one which we hope Mr. Lawrence's book will help to dissipate. The remaining portions of the work are devoted to electrical data concerning the human body, and are perhaps the more important. Some very interesting tables and charts are given, to illustrate the varying resistances observed in different regions of the body, at different times of the day, and in the same individual; and in this connection Mr. Lawrence justly points out that, in consequence of this varying resistance, widely different doses may be administered on successive days under the same prescription. A series of outline diagrams are added which indicate the motor points of the various parts of the body: they appear to be very similar to those of Eichhorst, but their source is not acknowledged. To each diagram is appended a table enumerating the principal muscles and their action. Possibly in such a work as this, intended as it is for non-medical readers, the actual names of the muscles might have been advantageously omitted, more especially as it is very seldom that a single muscle is alone concerned in any one particular movement, and *vice versâ*. For instance, the *digastricus* is the only muscle credited with the action of opening the jaw, and the *lumbricales* are said "partly to flex and partly to extend the fingers"—a statement which, in the absence of further explanation, may, to say the least, appear to be highly contradictory to the tyro. A very small portion of the work is devoted to massage, but the hints given are useful and accurate, though the same cannot be said of the two final diagrams, in which the anatomy is incorrect and misleading.

On the whole, we think that the author has done his work well, and, considering the small size of the volume, his book contains a large amount of practical information, which those who are in the habit of prescribing and practising electrical treatment will do well to master.

Digitized by Google

TELEPHONES FOR DOMESTIC USE.

The increasing demand for the telephone in large private houses, offices, warehouses, factories, &c., has led to the construction of several ingenious pieces of apparatus to facilitate the working of the telephone under these new conditions. One of the foremost in effecting improvements in domestic telephony has been the Consolidated Telephone Construction and Maintenance Company, and the following illustration (Fig. 1) shows a combination receiver, transmitter, call-bell, switch-board, and automatic switch, which is now being manufactured by them.

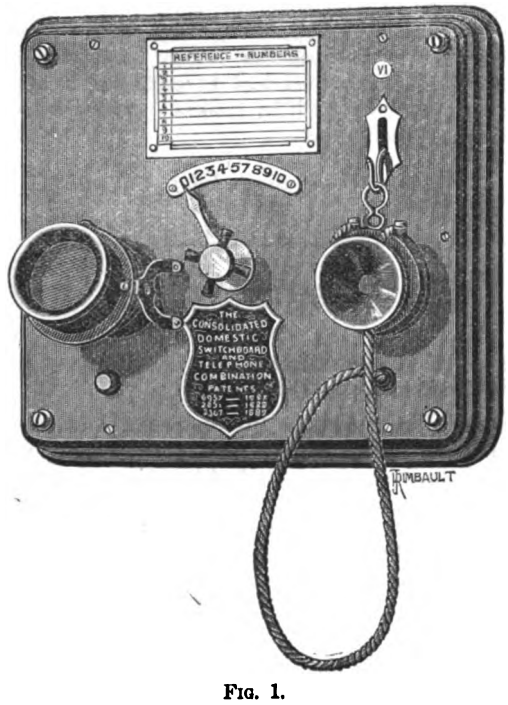

REFERENCE TO NUMBERS
0 1 2 3 4 5 7 8 9 10
THE CONSOLIDATED DOMESTIC SWITCHBOARD AND TELEPHONE COMBINATION
PATENTS
DIMBAULT

Fig. 1.

The patent automatic switch is of great value to the user, inasmuch as it is an utter impossibility for the pointer to remain on a used line. It returns automatically to its normal position after the user has spoken to whatever number he has wished. The working of this switchboard is as follows:—Supposing that a building of 10 rooms or offices have to be connected as a system. One of the combinations would be placed in each room or office. Say that No. 5 requires No. 3—No. 5 places the pointer to No. 3, presses the ringing button under the transmitter, removes the receiver from the switch-hook, and after conversation replaces it. The very act of his doing so causes the pointer to return to 0, and the line is thus cleared. The course of the current will be seen from the diagram (Fig. 2), which illustrates the principle of the entire system. It is from the

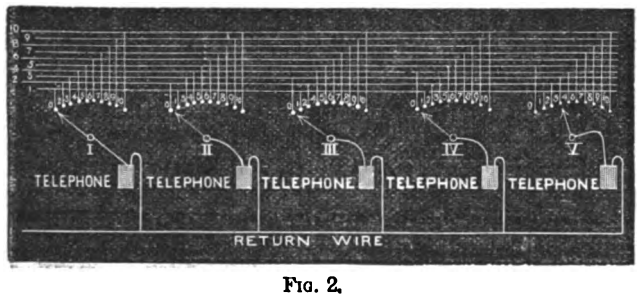


Fig. 2.

instrument at No. 5, through the contact pointer to stud 3, along the No. 3 wire to the 0 stud of No. 3 instrument, thence through the return wire to No. 5 instrument. Fixing, or replacing, or removing the combination is quickly done by reason of each connecting wire having a differently coloured covering. A desk instrument can be provided for a principal, so that communication can be made with all departments without his moving. A cheaper form of combination on this principle with the switchboard separate from the telephone, and non-automatic, is also made by the Consolidated Company.

This switchboard is much the same in principle as that designed by Mr. A. A. Campbell-Swinton, and was described in these columns some two years ago (*Electrician*, January 20, 1888, p. 268). The automatic switch forms, however, a decided improvement.

THE PHYSICAL SOCIETY.

ANNUAL GENERAL MEETING.

At the annual general meeting of this Society held on February 7, 1890, Prof. Reinold, President, in the Chair, the reports of the Council and of the treasurer were read and adopted. The former stated that there had been a very satisfactory increase in the number of members during the year. The number now exceeds 360, of whom 80 are Fellows of the Royal Society. During the year the Council had proposed to change the time of meeting of the Society from Saturday afternoon to Friday evening. The change was adopted by the members by a vote of 129 to 30, and had resulted in a large attendance at the meetings. During the year the second part of Vol. I. of the translations of important foreign memoirs had been issued to members, and it was hoped that the third part would be published early in the present session. The Council had to regret the loss by death of three well-known members—James P. Joule, Warren de la Rue, and Father Perry. A valuable collection of books had been given to the Society by the Royal Astronomical Society. From the treasurer's report it appeared that the balance of the Society had been increased by £120 during the year.

Prof. Hittorf, of Münster, was, at the recommendation of the Council, elected an honorary member of the Society.

The result of the election of officers was declared as follows:—President: Prof. W. E. Ayrton, F.R.S. Vice-Presidents: Dr. E. Atkinson, Walter Baily, M.A.; Shelford Bidwell, F.R.S.; and Prof. S. P. Thompson, D.Sc. Secretaries: Prof. J. Perry, F.R.S., and T. H. Blakesley, M.A., M.I.C.E. Treasurer: Prof. A. W. Rücker, F.R.S. Demonstrator: C. V. Boys, F.R.S. Other Members of Council: W. H. Coffin, Sir John Conroy, Bart., M.A.; Conrad W. Cooke, Major-Gen. Festing, F.R.S.; Prof. J. V. Jones, M.A.; Prof. O. Lodge, D.Sc., F.R.S.; Prof. W. Ramsay, Ph.D., F.R.S.; W. N. Shaw, M.A.; H. Tomlinson, B.A., F.R.S.; and G. M. Whipple, D.Sc. Votes of thanks were then passed—(1) to the Lords of Committee of Council on Education for the use of the room in which the Society has met; (2) To the auditors, Prof. Minchin and Dr. Fison; (3) To the President and Officers of the Society for their services during the year. The meeting was then resolved into an ordinary science meeting. Messrs. E. W. Smith and C. E. Holland, B.A., were elected members of the Society.

The Paper on "Galvanometers," by Prof. W. E. Ayrton, F.R.S., Mr. T. Mather, and Dr. W. E. Sumpner was then resumed.

DISCUSSION.

Prof. AYRTON first made some supplementary remarks on the Paper. Referring to the table given in the abstract which we published last week, he called special attention to the high values of a cubic inch of coil space in galvanometers of the d'Arsonval type, as shown by the last four columns of the table. He then called attention to the table given below referring to three of Elliott's galvanometers:—

No. of Galv.	r	M	D	V	I	DI	$D/r^{\frac{1}{2}}$	$DI/r^{\frac{1}{2}}$	$D/Vr^{\frac{1}{2}}$	$DI/Vr^{\frac{1}{2}}$
1	30,000	34,000	4,000	252	...	...	...	...	...	...
2	3,860	7,550	15,400	250	·01	154	566	5·66	2·26	·023
3	6,000	15,750	32,000	250	·01	320	1,180	11·8	4·72	·027

r = resistance in ohms, M = millimetres deflection when the period is ten seconds and the scale is placed as in the actual use of the instruments. D = deflection in scale divisions per micro-ampere when the period is ten seconds and the scale distance is equal to 2,000 scale divisions. I = moment of inertia of suspended parts in C.-G.-S. units (only approximate). V = volume in cubic centimetres occupied by the convolutions of wire (only approximate).

The instruments 2 and 3 had very light needles with two coils to each, and the suspension was seven inches in length. The values in the case of No. 3 were deduced from Elliott's data obtained by testing with a standard cell which they believed to be a Daniell, but Prof. Ayrton observed that it was quite possible a Grove cell might have been employed, as he believed this was Messrs. Elliott's usual practice. In that case the value of D for this instrument would have to be halved, but even so the result would be very good.

In reply to a question which had been put to him after the last meeting, he stated that, when necessary, the effect of electrification of the ebonite was eliminated by attaching one of the galvanometer terminals to the brass case of the instrument, in which case there would be no charge inside. This, however, was only requisite for measurements of very great delicacy.

With respect to the calibration of ballistic galvanometers, the Professor observed that the methods usually recommended were the employment of an earth inductor or of a condenser charged to a known E.M.F. by means of a standard cell, such as Clark's. The former method he objected to on account of its requiring the determination of the value of the horizontal

Digitized by Google

component of the earth's magnetic force at the place and time of observation, which was difficult and tedious to obtain with accuracy. The second method was open to objection on account of the unreliability of condensers where great accuracy is required. The method which he preferred was that of sending a constant measured current through the galvanometer to be tested.

Mr. BOYS did not agree with the authors of the Paper that the fairest method of comparing galvanometers of different types was under the condition of constant controlling moment, for he considered, as he had already pointed out in his lecture at the Society of Arts, that this gave an undue advantage to instruments of the Gray or Rosenthal type. If the suspended system of four coils in one of these instruments could be reduced in size indefinitely while retaining the period constant, it would ultimately assume the form of a very short magnet within a single coil, and then the deflections would become much greater than before. It was impossible to make very delicate instruments of this kind with silk fibres, as the perpetual shifting of the zero would be indistinguishable from the effects of the current, but if a spider line, or fibre of some other material not subject to this disadvantage—like silk—were employed, instruments of great delicacy and sensitiveness could be obtained. He had succeeded in making most satisfactory instruments of this kind with a needle one-eighth of an inch in length, and having a period as long as 20 seconds; and a group of such needles suspended within a very small coil would be far more sensitive than one of the Gray pattern with its **H** suspension. An instrument of this kind would certainly be more sensitive to external magnetic disturbances than one of the Gray type; but, on the other hand, a much smaller period would be requisite to give the same amount of sensitiveness, so that the magnetic changes taking place during an observation would be much smaller. His own experience led him to the conclusion that the best means of securing very great sensitiveness was to make all the moving parts as small as possible. In the instruments to which he had previously referred, with needles one-eighth of an inch long, the moment of inertia of the suspended portion was about ·0005 C.-G.-S. unit, and yet a period of as long as 20 seconds was obtainable. He thought that winding the inside layers of the coil in the reverse direction to the outer ones was open to the objection that it would make the magnetic field much less uniform, and therefore make it necessary to calibrate the instrument with much greater exactness than would otherwise be required. In making his radio-micrometer, he had supposed, like the authors, that electro-magnets would give the best results; but he found that this was not the case, for unless the amount of copper was double what would otherwise be required, the instrument, owing to the effect of induced currents, became so dead-beat that it would not sensibly move at all when the period exceeded 10 seconds.

Mr. SWINBURNE said that the efficiency of a galvanometer depended on its permanent figure of merit, and it seemed to be necessary to determine this differently for every different use for which the galvanometer was to be constructed. He did not see that there was any great advantage in modifying the construction of a galvanometer in order to obtain proportional readings, as it was easier for instrument makers to construct a scale to fit the galvanometer. He would like to know whether Prof. Ayrton had ever used Lippmann's so-called electrometer: was it not rather a galvanometer? And whether he had found it a sensitive instrument? He pointed out that the instrument alluded to by Prof. Ayrton as the d'Arsonval galvanometer was the same in principle as the recording arrangement employed by Sir William Thomson in the siphon recorder, and stated that it was originally patented, but without any mention of a mirror, by Varley. He thought the modification adopted by the authors of weakening the spring and replacing its action by means of a directing magnet was merely replacing one fault by another; and the spring was the more permanent arrangement. He had always thought that the method of calibrating ballistic galvanometers by means of a constant current was the one in ordinary practical use. At any rate it was employed by Hopkinson in his experiments on the curves of magnetisation of iron. Mr. Boys' argument about the Gray type of galvanometer appeared to involve the assumption that the size of a magnetic needle could be diminished indefinitely without diminishing the strength of the poles.

Prof. FITZGERALD observed that Lord Rayleigh had shown in a Paper read before the British Association that it followed from optical principles that the observation of the edge of the mirror by means of a sufficiently powerful reading microscope would be just as advantageous as the employment of a spot of light, however far the mirror was removed from the spot. A much greater advantage could therefore be obtained if a long pointer were attached to the edge of the mirror, and its position read by means of a microscope. The practical difficulty in the use of this method, however, was that it was impossible to distinguish between side-way motions of the mirror and its rotation, unless both ends were observed simultaneously, and he had made some attempts to devise a suitable arrangement for doing this. This difficulty did not arise when a spot of light was employed.

Prof. AYRTON in replying stated that he had never employed coils so small as those described by Mr. Boys, and with those he had used he had never found the damping to be too great; indeed, they had wound the coils upon thin strips of copper in order to increase the damping. They had moreover employed a stronger magnet than had ever before been used for the purpose in England for their most sensitive instrument. The exciting current of the electro-magnet was kept constant by including in the circuit an ammeter, the pointer of which moved right across the scale for a change of 0·1 per cent. in the strength of the current on either side of the desired value. He did not agree with Mr. Swinburne that proportionality of reading was a matter of indifference, as it was extremely difficult to construct a three-foot scale to follow all the vagaries of an instrument of the original d'Arsonval type. He was quite aware that M. d'Arsonval was not the first inventor of the type of instrument known by his name, but he had continued to call it by the name by which it was generally known, as M. d'Arsonval was the first to practically employ the principle in the construction of galvanometers. He had employed the so-called Lippmann electrometer, which was really a galvanometer, as it allowed an appreciable current to pass. It was in fact an extremely delicate voltmeter. He had thought the constant current method of calibrating galvanometers worthy of mention, because it was not described in any of the text books, even the most recent ones.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To night) FRIDAY, February 14th.

ROYAL INSTITUTION.

9 p.m. Lecture: "Problems in the Physics of an Electric Lamp." By Prof. J. A. FLEMING, D.Sc.

SATURDAY, February 15th.

ROYAL INSTITUTION.

3 p.m. Lecture: "Electricity and Magnetism." By the Right Hon. Lord RAYLEIGH, F.R.S.

MONDAY, February 17th.

LONDON INSTITUTION.

5 p.m. Lecture: "The Poetry of William Dunbar." By Prof. W. P. KER, M.A.

SOCIETY OF ARTS.

8 p.m. CANTOR LECTURE III. 1: "Stereotyping." By THOMAS BOLAS, F.C.S.

TUESDAY, February 18th.

ROYAL INSTITUTION.

3 p.m. Lecture, "The Post-Darwinian Period." By G. J. ROMANES, F.R.S.

SOCIETY OF ARTS.

5 p.m. Foreign and Colonial Section. Paper to be read, "Ocean Penny Postage and Cheap Telegraph Communication between England and all parts of the Empire and America." By J. HENNIKER HEATON, M.P.

INSTITUTION OF CIVIL ENGINEERS.

Ordinary Meeting. Papers to be read: "The Shanghai Water-Works." By J. W. HART, M.Inst.C.E. "The Tytam Water-Works, Hong Kong." By JAS. ORANGE, Assoc.M.Inst.C.E. "The Construction of the Yokohama Water-Works." By J. H. T. TURNER, Assoc.M.Inst.C.E.

ROYAL VICTORIA HALL.

8:30 p.m. Lecture, "Eyesight and Some of its Defects." By Dr. COLLINS.

WEDNESDAY, February 19th.

CIVIL AND MECHANICAL ENGINEERS' SOCIETY.

7 p.m. Ordinary Meeting. Paper to be read, "Italian Water Supply." By A. FAIRLIE BRUCE.

ROYAL METEOROLOGICAL SOCIETY.

7 p.m. Ordinary Meeting. Papers to be read:—"Observations on the Motion of Dust, as Illustrative of the Circulation of the Atmosphere, and of the Development of Certain Cloud Forms." By the Hon. RALPH ABERCROMBY, F.R.Met.Soc. "Cloud Nomenclature." By Captain D. WILSON-BARKER, F.R.Met.Soc. "An Optical Feature of the Lightning Flash." By ERIC S. BRUCE, F.R.Met.Soc.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Paper to be read: "The Organisation of Secondary and Technical Education in London." By Prof. SILVANUS P. THOMPSON, D.Sc.

THURSDAY, February 20th.

ROYAL INSTITUTION.

3 p.m. Lecture: "The Three Stages of Shakespeare's Art." By the Rev. Canon AINGER, M.A.

LONDON INSTITUTION.

7 p.m. Lecture: "Franz Schubert and his Successors." By CARL ARMBRUSTER.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary Meeting.

CHEMICAL SOCIETY

8 p.m. Papers to be read: "The Behaviour of the More Stable Oxides at High Temperatures." By G. H. BAILEY, D.Sc., and W. B. HOPKINS. "The Influence of different Oxides on the Decomposition of Potassium Chlorate." By G. J. FOWLER, M.Sc., and J. GRANT.

***** Particulars of meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.**

Digitized by Google

The Electrician.

Published every Friday. Price Fourpence; Post Free, Fourpence Halfpenny
Editorial, Publishing and Printing Offices:

No. 1, SALISBURY COURT, FLEET STREET, LONDON, E.C.

Telephone No. 2714. Telegrams: "ELECTRICIAN NEWSPAPER, LONDON."

All Communications to be addressed to "THE ELECTRICIAN," *1, Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN."

All letters intended for insertion in "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. Subscribers should receive their copies by the first post on Friday morning.*

"THE ELECTRICIAN" *is on sale at the railway bookstalls throughout the United Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices as above*

SPECIAL NOTICE.

Owing to the increase in the number of pages of "THE ELECTRICIAN," in order to partly cover the increased postage, we have been compelled to revise the rates for Foreign Subscriptions, which are now as follows:—

	3 months.	6 months.	12 months
For Foreign Parts and Colonies:—	s. d.	s. d.	s. d.
Within Postal Union	6 6	12 6	24 0
Aden, Borneo, Ceylon, China, India, Japan, Java, Labuan, Mozambique, New Caledonia, Persia, Philippine Islands, Siam, Transvaal, and Zanzibar	7 6	14 6	28 0
The rates for the United Kingdom remain as follows:—	5 0	10 0	19 6

TO ADVERTISERS.

"THE ELECTRICIAN" *offers exceptional advantages to Advertisers.* **It has the largest circulation of any English Electrical paper, and circulates all over the World.**

Particulars relating to Advertisements will be promptly forwarded on application to the office.

TRADE ADVERTISEMENTS *intended for the current issue must be handed in not later than First Post on Thursday morning.*

SMALL PREPAID ADVERTISEMENTS *(for Rates see page xiii.) are accepted up to 4:30 p.m. on Thursday.*

TECHNICAL PRINTING.

"THE ELECTRICIAN" PRINTING AND PUBLISHING COMPANY (LIMITED) *beg to inform Electricians, Electric Light Engineers, &c., that they make a specialty of Technical Printing, and have a Staff thoroughly acquainted with Electro-Technology. They can, therefore, promise Accuracy and Despatch in the Printing of Electrical Catalogues and Electro-Technical Literature generally.*

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.

Royal 8vo, 5s., postage extra.

Early in each year is issued "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK. *The* DIRECTORY *was established in 1883, and the 1889 Edition consisted of more than 600 pages of printed matter. The names and addresses of all persons engaged in the Electrical Industries may be relied upon as accurate. Useful Tables and Electrical Formulæ, and information specially compiled for this work are given, together with popularly-written Biographical Notices of the leading Electricians, Electrical Engineers, &c., accompanied in many cases by Portraits.*

The issue for 1890, which is still further enlarged and improved (making 850 pages), is NOW READY. Orders should be forwarded at once to the Publishing Offices, Salisbury-court, Fleet-street, London, E.C.

CONTENTS OF THE CURRENT NUMBER.

NOTES	361
Electricity and the Law. By A. C. Curtis Hayward, B.A.	366
Underground Mains.—V. By G. L. Addenbrooke. Illustrated. Continued	367
Reviews	369
Telephones for Domestic Use. Illustrated	370
Physical Society—	
Annual General Meeting	370
"On Galvanometers."—*Discussion*	370
Meetings of Scientific Societies.	371
TELEGRAPH AND TELEPHONE	372
The Institution of Electrical Engineers—	
The Theory of Armature Reactions in Dynamos and Motors. By James Swinburne. Illustrated	373
The Use of Electricity in Mines. By M. Chalon, C.E.	375
The Abdank-Abakanowicz Arc Lamp. Illustrated	376
American Notes	377
Paris Notes	378
Scandinavian Notes	378
CORRESPONDENCE—	
Cost of Electric Traction.—H. J. S. Heather	379
Mr. Kapp's Report on the Aron Meter.—A. K. C.	379
Trade Notes and Notices	380
Binswanger's High Insulation Ceiling Roses. Illustrated	380
LEGAL INTELLIGENCE—	
Blackburn *v.* The Lancashire and Yorkshire Railway Co.	381
PATENT RECORD	381
COMPANIES' MEETINGS, &c.—	
Chelsea Electricity Supply Company (Limited)	382
New Companies Registered	383
City Notes, &c.	383
Companies' Share List	384

"THE ELECTRICAL WORLD" OF NEW YORK.

"THE ELECTRICAL WORLD" OF NEW YORK *can be obtained from* "THE ELECTRICIAN" *Office, Salisbury-court, Fleet-street, London, E.C. The Rate of Subscription (payable in advance), is* **£1 1s.** *per annum. Single Copies* **price 6d. each; post free, 8d.**

"THE ELECTROTECHNISCHE-ZEITSCHRIFT" OF BERLIN.

In future the above journal (with which has been incorporated "The Centralblatt für Electrotechnik") will be issued weekly instead of fortnightly, the subscription being **£1. 4s. 6d.** *per annum. Single Copies* **6d.; post free, 7½d.**

"THE ELECTRICIAN" PRINTING AND PUBLISHING COMPANY, Ltd., *are Agents in Great Britain for both the above well-known journals, and particulars as to Advertisements will be supplied on application to "The Publisher," 1, Salisbury Court, Fleet Street, E.C.*

TELEGRAPH AND TELEPHONE.

The figures relating to the development of English telephonic business published in our annual summary for the year 1889 are sufficiently remarkable in themselves to deserve the careful study of those ingenious persons who take note of the statistics of novel and prosperous industries. But besides this they possess a significance for a far wider circle of students, and, indeed, for all classes of business or professional men who watch with anxiety the relations which continue to subsist between the telephone companies and the State telegraphs of this country. Those relations can hardly be said to be friendly: on both sides action has been taken which portends overt hostility at no distant date; and on neither side has there been overtures of a kind at all likely to lead to that co-operation which is so much desired by the public, and so necessary to the permanent welfare of the parties chiefly concerned. To every practical telegraphist it was evident from the moment of its discovery, that the telephone would sooner or later become either an adjunct or a rival to the telegraph itself; and when in this country the legal decision was pronounced that telephony was only a variant form of telegraphy, the absorption of the lesser by the greater was reduced to a mere question of opportunity or expediency. Its expediency has long been admitted; but the opportune moment has not yet arrived, though some people think it is not far off. Meanwhile the two systems work apart, the State having no telephony of its own

Digitized by Google

worth speaking of, and admitting no connection with telephony outside; while, on the other hand, the telephone companies have not only obtained a vast amount of business for telephony proper, but have developed it over widely separated areas, so that it is hardly distinguishable from the telegraphs, supposed to be exclusively worked by the State.

It it needless to go over once again the oft-told story of this unfortunate complication. Suffice it to say the representatives of the State telegraphs for the time being have swayed from side to side in their policy with regard to the companies, and until the last year or two have adopted no firm or consistent attitude towards them. Taking advantage of this vacillation the companies have pursued their course, as they were entitled to do, with a strict regard to commercial considerations, and latterly, no doubt with an eye to making the best bargain possible if the POSTMASTER-GENERAL should carry out his half-revealed intention of repeating upon them the *coup* which he successfully delivered last year at the now defunct Submarine Telegraph Company. Whether the telephone companies have acted wisely in their later developments is a question which the general public regard with perfect indifference. One thing, however, may be said as touching the outlook from a shareholder's point of view, namely, that long-distance telephony, as it is called, will test the financial soundness of the directors' calculations to the utmost; for splendid as it may look on paper, it has never yet been made to pay except in conjunction with long-distance telegraphy. American statements on the subject are altogether untrustworthy, and in any case are wholly inapplicable to our own country. France provides a safer illustration; and in France the State has rudely got out of the growing entanglement by absorbing the telephone companies' business on terms which nothing but compulsion would have rendered acceptable.

Most probably this example will be speedily followed elsewhere on the Continent; and in one form or other by the British Post Office on the very first opportunity, unless political exigencies should intervene to prevent it. And this not so much because the telephone is a competitor of the telegraph, as because the proper and legitimate functions of the State telegraphs are being gradually diverted into private hands. In other words, telephony being a mode of telegraphy, the public which bought the exclusive right to the latter have a right to exclusive control over the former. If the telephone had remained, as some people supposed it would, a sort of speaking tube from one house to another, no occasion would have arisen to take its management away from private speculation. But, much to their surprise, it has grown to be a speaking telegraph, yet with none of the advantages as regards cost and organisation which a State telegraph is bound to confer on the community. The telephone, in its present stage of development, ought, therefore, now to come under the control of the administration of that public department which has managed the telegraph so admirably that it is at once the cheapest and swiftest means of communication known in the whole world.

That the telephone, as at present administered by private hands is neither as cheap nor as swift as it might be under State control is notorious. And that the telephone companies' business has so remarkably developed under such adverse conditions is only another indication of what it might become if the two systems of telephony and telegraphy were combined under one administration. Some interesting particulars bearing on this point have lately been published in these columns from our Scandinavian correspondent, whose letters have furnished a striking illustration of what has been done with telephone and telegraph combined in the hands of the Swedish Government, and information which we have received from a valued Danish correspondent tells the same story with respect to Denmark. In both Sweden and Denmark the telephone lines controlled by the State are patronised almost as much as the telegraph, and the two systems, instead of impeding each other's development, unite to minister to the wants of the public. For the present private competition is not forbidden in Sweden, but is conducted under strict regulations, and the State telephone lines are pushed forward notwithstanding, with the result that the systems are worked at their very best, and at prices which make ours look exorbitantly high. According to our correspondent's letter, published in *The Electrician* of January 10th, the Swedish Government has authorised a sum of £8,000 to be expended annually on telephone extension; and, as an example of the manner in which it is being made to serve commercial purposes, mention is made of steamers while in port being connected by wire with their respective houses of business in the towns. No doubt a similar enterprising spirit would actuate the English State Telegraph Administration in respect to the telephone if considerations of fair play to the companies, from whom royalties are exacted, did not stand in the way; but as regards the companies, so long as they are free to do what they please, they will of course make the most of their opportunities, imposing the highest possible charges that the public can be induced to pay. Nobody can blame them for this, and the present Government is, perhaps, equally blameless in the matter. But this condition of affairs is extremely inconvenient to the public, and the sooner it is put an end to the better it will be for them, for the Government, and for the companies alike.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

THE THEORY OF ARMATURE REACTIONS IN DYNAMOS AND MOTORS.

BY JAMES SWINBURNE.

It seems to be generally supposed that electrical engineers are in full possession of means for calculating out and designing a dynamo or motor. This is no doubt the case as regards very small machines, and as regards large machines when considered with reference to no load. The effect of the armature current is mentioned in the classical Paper of Drs. J. and E. Hopkinson, the excitation necessary at full load being given in terms of the armature current turns and the lead of the brushes; but as the lead of the brushes is determined after the machine is made, that Paper gives the first step towards a solution of the armature reaction, but does not go farther. As not only the excitation necessary at full load, but also the best dimensions of the magnets and the proper shape of the pole-pieces, depend on the armature reactions, and as the armature reactions are of immense importance in large machines, such machines cannot be designed with accuracy unless the armature reactions and position of the brushes at full load can be foretold. The armature reactions are often regarded as obscure and unimportant phenomena, but, except in very small dynamos, the error due to neglecting them would be much greater than that due to neglecting the waste field, which has, of late, received so much more attention.

As most engineers are now in the habit of using C.G.S. measure, the C.G.S. system will be used in this Paper. The only new importation into dynamo work will be the idea of magnetic potential, as it is exceedingly convenient for explanation. The magnetic potential is, of course, the line integral of the magnetic force, and is 4π times the current-turns. As it is cyclic, we must take the line integral once round a circuit interlinked with the exciting circuit. Any point of the circuit may be assumed as of zero magnetic potential, but generally difference of potential is alone considered. The magnetic potential may be thought of as ampere-turns, or might be measured in ampere-turns; but as such a method is unusual, it will be taken in C.G.S. measure, being denoted by the symbol Ω; and for want of a unit of its own, it may be measured in ergs. An ampere-turn thus gives a magnetic potential of $4\pi/10$ ergs, or 1·26 ergs.

Digitized by Google

Magnets and Winding.

As single-magnet machines are very largely used now, and a type can be taken which is approximately that used by most of the large representative makers, such a machine may be taken as an example. A formula which gives the size of iron, and the excitation needed, will then be worked out.

The vertical line through the centre may be taken as at zero magnetic potential at no load. Assuming the length of the core to be the same as that of the pole-pieces, and calling the external radius of the core r, and the radial depth of the discs b, and the length of core a, and the armature induction B_a, the surface integral of the induction, or what may be for shortness called the total armature induction, is $2\,a\,b\,B_a$. The desired armature induction is here assumed. In practice different makers prefer different inductions, and to discuss the various considerations would take too much room, and would be outside the subject of this paper. The distance, l_a, which represents the length of iron that has to be magnetised to the induction B_a depends on the arc of embrace of the pole-pieces; but a large error in the estimate of this length causes a very small error in the design of the machine, as very little of the excitation is spent on this part of the magnetic circuit. The fall of magnetic potential over $\frac{1}{2} l_a$ is $\frac{1}{2} l_a B_a/\mu$, and may be written $\frac{1}{2} \Omega_a$. The induction in the air gap depends on the armature induction, the radial depth of the discs, and the pole-face angle. It will be written B_g. The line integral of the induction across the gap is $\frac{1}{2} g B_g$, where g is the distance across the gaps. $\frac{1}{2} g B_g$ may be written $\frac{1}{2} \Omega_g$. The fall of potential from the middle of the yoke to the pole-piece depends on the length of the circuit and the induction. It may be written $\frac{1}{2} l_m B_m/\mu$, or $\frac{1}{2} \Omega_m$. The induction that can best be used in the field magnets depends,

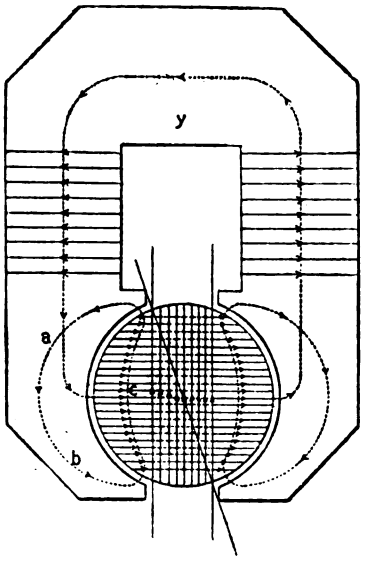


Fig. 1.

again, on many things that cannot be discussed shortly. As it is generally best to use a lower induction in the yoke, that must, of course, be taken into account. As the other half of the magnetic circuit is similar at no load, the line integral of the magnetic force needed in the shunt is $\Omega_s = \Omega_a + \Omega_g + \Omega_m$. As to the length of the field magnets, it depends on the total excitation needed. Different makers allow different lengths per thousand ampere-turns on the fields.

At full load the armature induction has to be increased to allow for the resistance of the armature and series coils, and sometimes for the leads also. A higher value is therefore taken for B_a, and therefore for Ω_a. The effect of the armature current itself may be divided into two components; and in the case of a drum armature, which may be taken for the sake of simplicity, the electrical effect is the same as if the external conductors were connected across the ends as shown in Fig. 1. There is thus a belt of current-turns opposing the field excitation, and another belt acting at right angles to it. These may be called the back and the cross ampere-turns, and the induction produced by them, the back and the cross induction respectively. The breadth of these belts, or the number of turns in each, depends on the lead of the brushes. For the present the lead of the brushes may be assumed. The extra difference of magnetic potential between the pole-pieces due to the back current-turns is $\pi\, C\, n_b/10$, where C is the armature current in amperes, and n_b the number of external armature conductors in the belt of back turns, n_a being the number of external armature conductors. This may be written,

$$\Omega_b = \pi\, C n_b/10 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

The difference of potential of the pole-pieces at full load is thus $\Omega_a + \Omega_b + \Omega_g$; and Ω_a and Ω_g are greater than at no load, because the armature and gap induction are higher. The difference of potential between the pole-pieces may be shortly written, Ω_p. In a given type of dynamo the percentage of waste field varies directly as the difference of potential of the pole-pieces, provided the field-magnets are not strongly magnetised, and is independent of the linear dimensions. The actual waste field, however, varies directly as the difference of magnetic potential between the pole-pieces, and directly as the linear dimensions, or as the diameter of the armature. If the armature cross-sectional area is $2\,a\,b$, and the armature induction is B_a, and if the field induction desired is B_m, the cross-section of the field-magnets must be

$$A_m = 2a\,b\,\frac{B_a}{B_m} + \frac{r\,\Omega_p}{M\,B_m} \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where M is a coefficient depending on the type of the machine. This coefficient can be readily determined from another machine of the same type but of different size, and an error in its estimation makes comparatively little difference in the dynamo.

In ordinary single-magnet machines M is generally about ·08 to ·085; in double-magnet machines it is less. Of course a great deal depends on the mounting of the dynamo. A machine let into a bed-plate, as is often necessary in the case of direct-coupled engines, has more leakage.

An equation for the shunt and series excitation is now to be found. From (1) the field induction is found—

$$B^m = \frac{2\,a\,b\,B_a}{A_m} + \frac{r\,\Omega_p}{MA_m} \quad . \quad . \quad . \quad . \quad (3)$$

Giving the value of B_a and Ω_p at no load, the value of B_m at no load is obtained. The shunt excitation is thus

$$\Omega_s = l_a B_a/\mu + g B_g + l_m B_m/\mu_m \quad . \quad . \quad . \quad . \quad . \quad (4)$$

in ergs, or this number divided by 1·26 in ampere-turns. By giving the full-load values of B_a and Ω_p the total excitation,

$$\Omega_s + {}_m = l_a B_a/\mu_a + \pi\, C\, n_b/10 + g B_g + l_m B_m/\mu \quad . \quad . \quad (5)$$

is obtained, and, of course, the difference gives the series excitation. Of course the full-load field induction has already been assumed in finding the size of the magnets.

It must not be forgotten that all this time it has been assumed that the lead of the brushes, and therefore Ω_b, is known.

Returning to Fig. 1, a closed line, $a\,b\,c$, may be drawn which is interlinked with all the armature conductors under the pole-piece. The magnetic potential round this circuit is

$$\Omega_c = \theta\, n\, C/10 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

when n is the number of armature conductors, and C is the armature current as before, and θ is the angle of embrace of the pole-piece. As the permeability of the iron, both in the part of the armature and of the pole-piece through which this line passes, is great, the whole difference of potential may be taken as being between the core and pole-piece. The induction under the leading corner, due to cross current-turns only, is then $-\frac{n\,C\,\theta}{2g \times 10}$, and under the trailing corner it is $+\frac{n\,C\,\theta}{2g \times 10}$. The field is thus weakened under one corner, and, provided the permeability of the iron is practically infinite, equally strengthened under the other, being at its normal value half-way down. The cross induction has in this case no direct effect in increasing or lessening the E.M.F. of the machine. If a dynamo were enlarged to scale, the field excitation would increase as the linear dimensions, but the armature current-turns, assuming the same current-density, would increase as the square of the linear dimensions. If the electromotive force of the machine were kept the same, they would increase faster, as the insulation would take proportionally less room. It is thus evident that a size would soon be reached when the cross induction under the leading corner would be equal to the normal induction due to the field excitation, and there would be no field to reverse the current in the section being commutated. The size at which this takes place varies according to the practice of makers, and is generally above the size in common use, as the output of a given armature is generally much smaller than might be taken from it. Machines with single magnets, and fairly large outputs for the size of their armatures, become difficult to design when they have armature above 35 to 40 cm. diameter. The fault can to some extent be corrected in single-magnet machines by making the polar angle —that is, the area of the pole-face—small. There are then fewer cross current-turns, and the induction in the gap is greater, so there is less chance of reversal of induction under the leading corners. This demands more field excitation and larger field magnets, as the difference of magnetic potential between the poles is greater, and so the waste field is greater. If the pole-pieces are made small, so as just to carry the induction due to the field coils without saturation, one side will be to some extent saturated by the addi-

Digitized by Google

tional induction due to the cross current-turns. In Fig. 2 the pole-piece is small across $a-b$, and the iron may need some magnetic force there, so the whole of the magnetic force of the cross-current turns will not be spent on the gaps, and the cross induction will thus be less. On the other side, of course, the cross induction is not lessened, as the iron is less magnetised. The resulting field will not be symmetrical. If the armature is Gramme-wound the lower brush will need more lead than the upper. Sparking at the lower brush in single-magnet Gramme machines has been frequently noticed by dynamo makers. Of course, it may be partly due to the poles being too small in section, so as to throttle the main induction of the field-magnets, but it is much more often

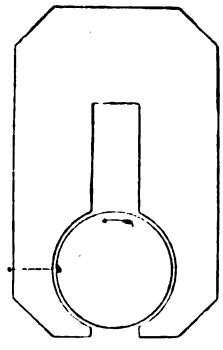


Fig. 2.

caused by the cross induction. If the armature is drum-wound, throttling the cross induction on one side will do some good in lessening the cross induction; but it is difficult to throttle the cross induction without also throttling the field induction proper, and wasting field exciting power.

Fig. 2 may be taken as a diagram of a 30cm. or 12in. armature machine of about the usual type, with the magnets rather close.

If there were no cross induction the pole-pieces would not be strongly magnetised anywhere, but when the cross induction is superimposed, the neck reaches a high magnetisation, the in-

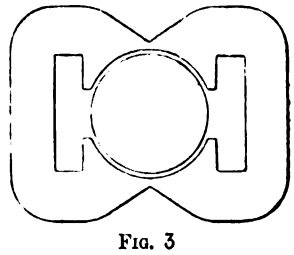


Fig. 3

duction in this case amounting to about B=15,800 there, and to about B=17,200 a little higher up. If it were not that the cross induction is lessened by the saturation of the iron, the neck would rise to B=17,500, and in the region 5cm. or so above the centre line to B=18,600. The difference of magnetic potential between a point a little below the middle and the top of the pole-piece comes to about 1,880 ergs. The effect of this is that more than 1,000 extra ampere-turns are required on the field-magnets. In a Gramme machine the effect is very easily observed by the use of a pilot brush. A resistance of, say, 100

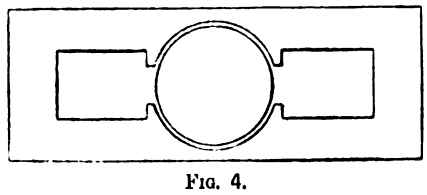


Fig. 4.

ohms is connected between the terminals of the machine. The pilot brush is connected to one terminal of a detector, and the other terminal is connected successively to points in the resistance corresponding, say, to 95, 90, 85 ohms, and so on. The positions of the brush for the zero readings are noted. This avoids errors due to slight variations of speed, which give trouble in the first instance, and errors due to bad contacts. With a drum this method does not give the distribution of the field, as each convolution is on both sides of the armature; but if one pole-piece is highly magnetised by the cross induction, the half of the armature under the upper left and lower right-hand halves of the pole-pieces (in Fig. 2) gives a lower electromotive force than the other. This effect is sometimes very marked in machines with cast-iron pole-pieces.

A double magnet two-pole machine can be made up to a larger size than a single by shaping the pole-pieces so as to throttle the cross induction. Two common types of machine are shown in Figs. 3 and 4 with the pole-pieces so cut. If it be assumed for the moment that the armature-section current can be reversed with no appreciable field, the largest pole-angle that can be used is when the gap induction due to the field excitation is equal and opposite to the cross induction under the leading corner—that is, when

$$\theta = 2\sqrt{\frac{b\,y\,B_a \times 10}{n\,C\,(r+\frac{1}{4}y)}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

As the armature sections need a sensible field to reverse them, the pole angle must be less than this.

(To be continued.)

THE USE OF ELECTRICITY IN MINES.*

BY M. CHALON, C.E.

The applications of electricity to underground work are becoming so numerous that it is possible to predict that in the near future the electric current will be used nearly everywhere in place of mechanical power. Even in coal mines, which are now so admirably equipped with mechanical appliances on account of the economy necessary in order to sell their output, steam, compressed air and water under pressure are being slowly replaced by the electric current. It may be employed for lighting at the bottom of the mine, and at the same time for a similar purpose on the surface, and for the communication by signals, and for the telephone. It will furnish at any depth, at different levels, and at various distances, the motive force for underground haulage, by cable or inclined planes; for the removal of material thrown by blasting; for pumping water; for ventilation; for drilling; for coal cutters, and, indeed, for running motors and machines of all kinds. All these many applications require only a dynamo engine and conducting wires.

It is in metalliferous mines that the application of electricity is becoming most valuable. Such mines usually possess many disadvantageous conditions for working, because they are almost always situated in districts that are not easily accessible, where fuel is expensive, and where transportation is an almost insurmountable difficulty. In such cases there is usually in the vicinity some waterfall, a swift river, or even a simple stream, whence the natural power may be transformed by the aid of a turbine and a dynamo, into currents of electricity which may be used for lighting, for the breaking and transportation of the ore, and even for the treatment of the ore at the mine by electrolysis or heat. In some cases, it is possible to sink an artesian well to produce an artificial waterfall by means of a reservoir more or less elevated. Indeed, it is possible to predict that the time is not far distant when it will be possible to work all mines with profit, especially those which from their inaccessibility have been thue far allowed to remain unproductive.

The Firing of Blasts by Electricity.—The use of the electric current for igniting charges of powder is perhaps the oldest application of electricity in mines. It is much more economical to fire charges by means of electricity than by the use of fuses, as is shown by the following tables in the case of sinking a shaft of 500 metres:—

	Francs.
Expenses of material and of a magneto machine for four simultaneous blasts, in sets of either 6, 8, or 9	80
Five hundred metres of double conductor, consisting of two wires covered with gutta-percha and cotton, and wrapped together with cotton thread, at the rate of 16 francs for 100 metres	80
Putting in place and sundries	25
Total	185

The operator requires no aid, for if the wires break, or are worn by rubbing, they can be easily repaired; hence they should last for years. Nevertheless, their cost price should be saved in a single year. In a large mine it is not too much to calculate an average of 4,000 to 5,000 blasts each year, and with this apparatus it would be equivalent to 4 centimes for each firing.

The cost of firing is (*a*) when powder is used—

	Centimes.
A simple primer for a spark with 1 metre of double conducting wire	10
An iron coupling wire covered with cotton, costing 3fr. a kilogram, with a length of 1½ metres, of which the price would be 7½ centimes. The loss from a series of explosions would not exceed 5 per cent.	0·37
Total	10·37

* Abstract of Paper read before the Mining and Metallurgical Congress, Paris, September, 1889.

Digitized by Google

(*b*) When dynamite is used—

A primer with a detonator containing 0·75 grammes of fulminate and a double conductor of 1 metre	15·
A coupling wire, with loss of 5 per cent. as before	·37
Total	15·37

The double conductor of the primer may be collected after the explosion, and may be used again as a coupling wire, or for other purposes. Its value may be estimated at 1 centime.

The running expenses after taking off this amount are :—

	Centimes.
(*a*) Using powder	9·37
(*b*) Using dynamite	14·37

Total cost as follows :—

	a. Centimes.	*b.* Centimes.
Material and plant	2·00 ...	2·00
Running and expenses	9·37 ...	14·37
Total	11·37 ...	16·37

Comparing these figures with those corresponding to the use of fuses, we find that with powder the cost is with ordinary fuse 6·5 centimes, and with gutta-percha fuse 25 centimes. With dynamite and ordinary fuse it is 12 centimes, and with gutta-percha fuse 29·5 centimes. The use of the ordinary fuse would appear at first sight to be the most economical, but it must be remembered that this fuse is but little used, even in dry work, because it is more easily injured and its manufacture is less careful. Besides, it is frequently doubled, in order to obviate the chances of failure. But the comparison between the prices obtained from the ignition by the use of a gutta-percha fuse or by electricity is altogether in favour of electric fuses. If, in addition to the fact of its economy, that by the latter process perfect security from danger is obtained, a much greater advantage is gained, and, finally, a better utilisation of the explosive material is secured in consequence of the simultaneous explosions; hence it can be safely accepted that the use of electricity is necessary, and soon will be used for all working in mines, espe cially in the excavation of shafts.

Lighting.—Electric lighting in mines consists of two kinds:—First, permanent lighting by stationary lamps, and second, lighting by portable lamps. In the first case arc lamps are used for all work on the surface, while incandescent lamps are employed for underground work. It is underground that the advantages of electricity are particularly appreciable. The work becomes more sure, more regular, more rapid—and, a circumstance which seems strange to relate, it appears that the moral nature of the miner improves with the environment of an agreeable light. Permanent lighting is not applicable to the working faces. The use of portable lamps attached to the principal conductors, as was tried at first, is dangerous, and, above all, inconvenient. The coming in contact produces a spark, and besides, the moving of the switch-board offers considerable difficulty, as a false movement may crack the glass, break the cable, or expose the insulation. It is, therefore, necessary in the drifts and working faces to make use of a lamp that is independent of all conducting wires, easily transported, capable of being suspended from the roof, attached to the walls, placed on the ground, or, in a word, a lamp that can be moved in all directions without losing its luminous intensity. To the same degree that the problem of permanent light is simple and easy to solve, so is that of portable lamps complicated and difficult. The following are the requisites for a good electric lamp for miners:—It should first be of simple construction and solid; second, as light as possible; third, easy to take care of and recharge; fourth, furnish a light having an intensity nearly constant for eight hours; fifth, have a lighting power of 1 to 1½ candle-power as a minimum; and sixth, be inexpensive. In making comparison, we use as standard the Davy safety lamp (Clanny, Marsaut, Mueseler, Fumat, &c.), and it will be recollected that they are simple and solid, that the weight does not exceed 1 to 1½ kilograms, that they yield a constant light of from ⅛ to ½ candle for 10 hours, at an average expense of 15 centimes for each filling. One of the first portable electric lamps was that made by M. Trouvé, in which the generator of electricity is a bichromite battery, but the incandescence is only produced when the lamp is carried in the hand or suspended by a hook. Unfortunately the Trouvé lamp is heavy, its light is not steady, and it does not last longer than two hours. Numerous models of lamps, with primary and secondary batteries, were submitted to the English Commission on Accidents in Mines (1879-1886), but none received approbation. Since 1886, however, considerable progress has been made, and good accounts have been received of several lamps that are used in English mines, such as the Schanschieff and the Friedlander lamps, with primary batteries, and the Swan, Pitkin, and Higson lamps, using storage batteries. Swan has constructed an indicator which he adds to his portable electric lamp. He takes advantage for this purpose of the well-known property that a red-hot platinum wire has of becoming more brilliant in a fire-damp atmosphere than in pure air. It is difficult to say which variety of portable lamp is the best. It is certain that in mines where there is already a good electric plant a lamp with a secondary battery may be used with advantage, but in all other cases a primary lamp is preferable. It is true, however, and must be said, that as yet no lamp with a primary battery exists that is really practical and adapted to the exigencies of portable lighting in mines. The lamps actually in existence are far from fulfilling all of these desiderata. Some are too expensive, too heavy, too cumbersome, or have too great a resistance, while others contain corrosive liquids or are subject to electrical leakage.

Signals.—In mines where an electric current is in use all of the working places in the mine and the surface are connected by bells or a telephone system. The code of signals is generally very simple, and consists only of one, two, or three bells. By means of signals and the telephone, a permanent and instantaneous communication is established between the bottom of the mine and the surface. The mine ceases to be isolated, and it may be said that all its movements, all its pulsations, are registered above ground. In case of accident, aid may be called for and sent to the exact locality at once. The combination of signals, and the electric light in the workings, makes possible a greater rapidity in the method of mining.

Machine Drills.—The operation of drilling by percussion with electricity offers great difficulty, but, nevertheless, some interesting experiments have been made in the United States by the Sprague Electric Motor Company, the Union Electric Company, and various engineers. In all the experiments the bit is connected by a crank to the armature of an electric motor, in which every revolution corresponds to a blow struck by the tool. The application of an electric motor to rotary drilling, such as a steel cutter or diamonds, is much easier, for the motion of the armature may be communicated directly to the gearing that controls the tool holder. Taverdon has made some attempts in this direction with his diamond crown drill. Tedesco has also sought to apply the use of electricity to his drills.

Mechanical Cutting.—The electric cutting machine of Messrs. Bowes, Blackburn, and Mori has been recently (1887) tested in England. The part carrying the tool-holder, which consists essentially of a plate provided with blades or knives in the form of a star, receives its force from an electric motor located in the same frame and having a force of 6 to 9 horse-power. This motor is connected by flexible conductors to a dynamo. The cutting wheel describes a quarter of a circle in the coal mass, which it cuts away to the depth of about a metre. The carriage is attached to a wheel and axle, by means of which it can be moved along the face. It is possible to dispense with attaching the motor to the carriage, but then it is necessary to move it by chains, or by means of a rope and pulley. The Lechner cutting machine tested in the coal mines of Pennsylvania is attached to an electric motor transmitting power by means of a cord. A single motor will do the work of three cutting machines operating successively, thus permitting continuous working, for while the second or third cutting machine is in operation, the coal cut by the first can be loaded.

THE ABDANK-ABAKANOWICZ ARC LAMP.*

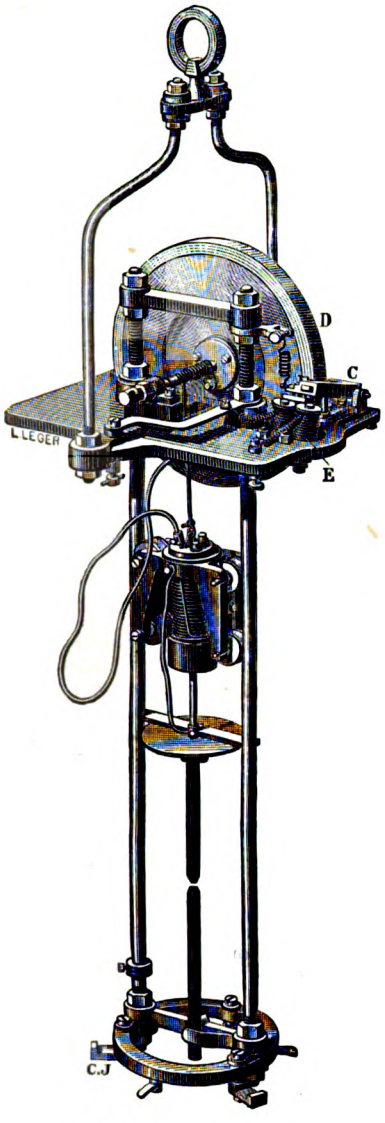
The Abdank-Abakanowicz arc lamp consists of two totally separate pieces of apparatus, namely, the lamp proper, and a sort of relay placed within reach of the hand. The upper carbon is suspended from a cord wound round the axle of a heavy fly wheel, D, which is braked by C. The brake C forms part of the armature of an electro-magnet, E, which is arranged as a shunt across the lamp terminals. Whenever the carbons become too far apart the relay sends the current through E for a fraction of a second, and the fly-wheel being momentarily unbraked rotates and brings the carbons together. The fly-wheel being relatively heavy, it moves very slowly at first, and as the brake is almost immediately applied again, the *vis viva* of the fly-wheel is soon annulled. If the motion is not sufficient, the fly-wheel is freed a second or third time. When the relay is in proper order, D is practically always in motion, and the carbons approach each other continuously.

This heavy fly-wheel is a very simple and effective substitute for the complicated clockwork found in so many lamps. The frame containing the upper carbon-holder comprises an electro-magnet which strikes the arc. The relay which is, as we have stated above, quite distinct from the lamp itself, comprises (i) a differentially wound electro-magnet the armature of which actuates a switch, which turns the current into the coils of the electro-magnet E whenever the arc lengthens; (ii) a fine wire solenoid and metallic

* Translated from M. Hippolyte Fontaine's "Éclairage à l'Électricité," by kind permission of the author.

Digitized by Google

bridge dipping into mercury, intended to act as a cut-out in case of accident; (iii) a switch for introducing a resistance into the circuit equal to that of the arc, whenever it is required to temporarily shut down the lamp.



Abdank-Abakanowicz Arc Lamp.

Although but little used, the Abdank-Abakanowicz lamp is a most ingenious one, and it worked very well at the Vienna Exhibition of 1883.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *February* 1, 1890.

Electrical Insurance.—It has now been proposed to organise and incorporate a company under the name of the Electric Mutual Insurance Company, which shall insure electric light and power stations through the United States, and possibly in Canada, against loss or damage by fire. The movement has been on foot for a long time, but has never taken definite shape till now, and it seems likely that it will be carried to a successful issue. It is estimated that in this country there are over 1,000 central stations, with a probable average valuation of no less than $25,000 each, making, on a moderate valuation, an insurable valuation aggregating $25,000,000. This novel and hopeful scheme, which has the endorsement of the Manufacturers' Mutual Insurance Companies of New England, has also the hearty approval of the Committee of the National Electric Light Association and the Insurance Committee of the Edison Association of Illuminating Companies, and it is, moreover, recommended by a large number of leading men in the electric lighting industry, including Mr. Edison, Prof. Elihu Thomson, Mr. Frank Morrison, Prof. Anthony, and many others. It is hoped and believed that the company will be a success from the start, and the indications of its success are already numerous. The exactions to which some of the companies have been subjected have for some time past been almost unbearable, and it has been only a question of time when this scheme would actually strike root, as it has now done.

Electric Welding.—It is more than likely that the development of electric welding will be attended with the discovery of a large number of new phenomena, the new applications leading, in fact, to the upgrowth of a distinctly new class of inventions. In such a category belongs the idea or principle the discovery of which is claimed by Mr. C. L. Coffin, of Detroit, and for which he has just secured a patent. The inventor proceeds in the regular way of electric welding by pressing the ends of the pieces together, but instead of relying merely on the resistance of the contact to generate the welding heat required, he claims to have discovered that by subjecting the joint to the influence of a magnet acting across the path of the current, the electrical resistance of the joint is secured, and the heating effect of the current is enhanced. He also finds that after the two pieces have been joined together a better weld may be obtained by ceasing to press the joint together, and, on the contrary, by applying stress tending to separate the joint while the current is passing—taking care, however, not to rupture the weld. This action, he asserts, increases the electrical resistance of the joint, and necessarily increases the heat again. This process is only applied for a short time, and the joint is finished as usual by rolling or hammering. I may mention incidentally that the Thomson-Houston welding process is now regularly recognised as a valuable addition to the arts here, and is being applied to a great many industries.

The Electric Motor Business.—An interesting review of the electric motor situation, and of the relation of the electric motor business to the electric lighting companies, has just been made by Mr. W. H. Fitzgerald, of Detroit, one of the pioneer electric lighting superintendents in this country. Mr. Fitzgerald, who has recently made an investigation on the subject, states that he finds there are to-day in operation in the United States stationary motors taking from 5,000 to 10,000 horse-power of current, probably near the upper limit, and about 6,000 to 8,000 small motors of one-eighth to one-tenth horse-power running sewing machines, fan outfits, &c. The confidence of the public in the electric motor is made more evident every day by the inquiries from shops and factories using from 20 to 100 horse-power, and even higher. He mentions many factories employing electric motors, such as one at Harrisburgh with 200 hands, one at Detroit with 140, and one at New York with 200, besides the factory of the C. and C. Motor Company with 150 hands, which is operated by its own motors. To this list, which might be made much longer, I will only add one other instance, that of a plant in Chicago, where a 40 horse-power Thomson-Houston motor was put in at a moment's notice to run a large printing-office where the steam plant had suddenly broken down, and where the necessary repairs and refitments with steam would have taken two or three weeks at the least. Mr. Fitzgerald, as the result of a long experience with different classes of motors, expresses himself in favour of the constant potential motor, and of circuits not exceeding 500 or 600 volts. He advises his colleagues to secure large power users, and to sell the power cheaply. He advises the companies also to control the motor sales or their rentals themselves, and he considers it a mistake where the central station takes no hand in the sale of the motors, affecting injuriously the customer and consumer alike. "Where there are three and four, and sometimes more motor salesmen in a town, by the time a prospective buyer has had a call from them all, he is ready to believe that a motor may be made either of iron or green cheese, and that the electric light company will sell him amperes by the bushel and volts by the long ton, and is generally demoralised, and as a result buys a gas machine." Mr. Fitzgerald also makes some interesting observations as to the price at which the central station can

Digitized by Google

afford to sell power, and says that prevailing records justify the statement that in a factory contracting for 50 horse-power in motors at the rate of $50 per year per horse-power, not over six-tenths of this power will be used on an average, so that the company would actually have to deliver to the customer not more than 30 mechanical horse-power. The receipts from such an installation would be $2,500, or a profit of $841, equal to $28 per horse-power on the power actually delivered. Hence Mr. Fitzgerald considers that as a general thing $50 or $60 per year per horse-power, based on the indicated horse-power of the motors, is a fair price at which to sell electric motors in units above 20 or 30 horse-power.

The Lighting of the Chicago Auditorium.—As an instance of the manner in which some of our larger buildings are now being lighted up with electrical apparatus, note may be made of the Chicago Auditorium, which is believed to be the finest building in America, and therefore we may say, with our characteristic modesty, the finest of the kind in the world. This building, which is intended to be, in the amusement line, what Whiteley's great emporium is in that of clothing and general supplies, has a dynamo plant with a capacity of 12,550 Edison 16 candle-power lamps. These lamps are distributed all over the house, and some remarkable lighting effects are obtained with them before the stage and behind it. The electric current is also used for power purposes. There are employed for ventilation three Thomson-Houston motors of 5, 7½ and 15 horse-power; three C and C motors of the same capacity, and two Eddy motors of 10 and 15 horse-power, making a total of no less than 80 horse-power of motors. Electric motors run the bellows for the grand organ, and this organ, again, is operated electrically, there being miles of wire in its circuits.

The Young Circuit-Breaker.—Some of the recent accidents occurring with broken live wires have drawn attention to the desirability of having some apparatus that would render the circuits harmless to those who are by accident or necessity brought into contact with the wires. The broken ends of a live wire may also fall across the ends of other conductors or on tin or corrugated iron roofing, and maintain a circuit practically complete, producing dangerous crosses. To avoid this trouble has been the object of several inventors recently, and a very excellent and practical device has just been brought out by Mr C. G. Young, by means of which the circuits are rendered harmless in case of rupture. Mr. Young's circuit-breaker is composed of two single electro-magnets, the bobbins of which are of metal. One end of the wire with which the magnets are wound is permanently connected to the metal bobbin, while the free end is carried to the binding posts. At the bottom of the magnets are circuit-breaking levers, held in position until the current is started by automatic latches. When current is generated by the dynamo, the magnets so influence their armatures as to maintain the circuits to line complete; but should the line become cut or broken from any reason whatever for one instant only, the magnets immediately become demagnetised, the levers drop from contact with the magnet cores, and the circuits to the dynamos are instantly ruptured at two points. Such devices as this should, I think, be put upon every arc light dynamo in the country. The mere fact of its presence, and its cutting out the dynamo as soon as the necessity arises, would tend to make the station superintendent more vigilant in the supervision of his exterior circuits, and with circuits thus protected there would certainly no longer be the insane fear which now possesses so many people as to any kind of wire whatsoever.

PARIS NOTES.

(FROM OUR OWN CORRESPONDENT.)

February 11, 1890.

Several of the central stations in Paris are of interest, owing to the peculiar systems of distribution employed. Take, for instance, the generating station situated in the cellars of the Bourse du Commerce. The engines are driven by compressed air, at a pressure of 7 kilogrammes to the sq. cm. (100lb. to the square inch), from the compressed air station in the Rue St. Fargeau, some four kilometres distant. These engines drive dynamos, which charge accumulators, and the accumulators finally supply current to the lamps. It does not require much knowledge to see that such a system must be both costly and inefficient, and it is difficult to understand what can have been M. Victor Popp's idea in adopting it. The Société de la Transmission de la Force à Distance, is actively engaged in laying its mains and in uniting its stations in the Rue de Bondy and Rue des Filles Dieu to the new generating centre behind the Gare du Nord. At the present moment these stations supply current direct, but they will shortly receive high-potential continuous current from a station situated at Saint Ouen. This high-potential current will be employed to drive motors, which in their turn will drive low-potential dynamos. At first sight this method does not seem likely to prove as efficient as an ordinary continuous-current transformer system—such as the one which is, I believe, in operation at Ipswich.

The Conseil Municipal has decided that the Rue Baltard shall be lighted by incandescent lamps. The Rue Baltard is a fine street running across the Halles Centrales from the Pont Neuf to the Pointe St. Eustache. The current will be supplied from the municipal station, and three 33-volt 2-ampere Gérard lamps will be placed in each gas-lamp.

In the Chamber of Deputies a few days ago M. Fouquier called attention to a petition from 850 subscribers to the Paris telephone exchange, complaining of the new State management. M. Tirard, in reply, claimed credit for the French system for superiority in point of audibility. M. Fouquier, he added, had complained of the incivility of telephonists, but had said nothing about the insulting remarks frequently addressed to the girl operators by the subscribers.

An important decree relating to the establishment of provincial telephone systems has just been issued. With characteristic precision the telephone systems are divided into elementary and compound groups: the former consist of a central exchange and its sub-exchanges, the latter of a group of telephonically-connected central exchanges. A subscriber to a sub-exchange may be placed in telephonic communication with his central exchange on paying the annual sum of 10fr. per kilometre of wire connecting the two exchanges. A subscriber belonging to an elementary group may have the privilege of telephonic communication with any subscriber belonging to the compound group by paying an additional annual subscription of at least 150fr., from which, however, will be deducted the annual amount paid for connection to the central office. These charges, which are by no means exorbitant, have been calculated so as to merely reimburse the State for its first outlay. A similar plan has given excellent results in the Departement du Nord around Lille, and seems likely to greatly facilitate telephonic development in the provinces.

SCANDINAVIAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

COPENHAGEN, *February* 1, 1890.

The Christiania Telephone Company have recently increased their capital by 250,000kr., as the present capital of 500,000kr. was fully engaged. The dividend is not expected to be less than 5 per cent.

The arrangements for electric lighting at Sundswall, Sweden, are now progressing, and tenders have been received, amongst others, from the Thomson-Houston Company, through their agents, the Bell Telephone Company, Stockholm, and from the Elektriska Aktiebolaget, Stockholm. Offers of boilers, &c., have been tendered by some of the leading manufacturing engineers in Sweden, the Corporation having voted 350,000kr. for the building of a central station intended for both street and house lighting. The installation will comprise 100 arc lamps and 2,000 incandescent lamps.

The chief director for the Swedish State Telegraphs, Mr. D. Nordlander, has sent in his resignation, as he does not approve of the contemplated amalgamation of the Postal Department and the Telegraphs. Mr. Nordlander has been acting in his above capacity since 1874. The Corporation of Jönköping, Sweden, has granted the Stockholm General Telephone Company concession for 12 years to work telephones in that town under certain restrictions. The annual charge per telephone is not to exceed 50kr. (£2. 15s. 6d.), and double wires are to be used. The telephone company is also to place its exchange in communication with the telegraph office. The telephone line between Stockholm and Uddevalla, *viâ* Gothenburg and Venersborg, has now been completed. The distance amounts to 630 kilometres, but the line acts perfectly satisfactorily.

The Norwegian State Telegraphs show a material increase in the number of telegrams despatched during the past year, or at least

Digitized by Google

during the first ten months of the same, the figures for the complete year not yet being obtainable. During the first ten months of 1889 738,377 inland telegrams and 423,142 foreign telegrams were despatched, as against 642,073 inland and 397,920 foreign during the same period the previous year. The receipts for this period during 1887 and 1888 were respectively 1,186,000kr. and 1,052,000kr. During the last financial year (July 1, 1888—June 30, 1889) the estimated receipts of 850,000kr. were exceeded by 163,165kr. For the present financial year there are several votes for new telephones and telegraphs, viz., completion of the Lillehammer-Bredevouzler telephone (since opened), with eight State telephone stations; telephone between Tonsberg and Aasgaardstroud (also opened); telegraph from Sandtoro to Liland (also opened); telegraph from Södingen to Risohavn, first vote towards a line Vodsö-Mehavn.

The General Telephone Company at Stockholm has during the last year had 10,536,036 conversations, against 8,768,408 during the previous year. The same Company has informed the members of the Swedish Parliament, which has recently assembled, that members can have telephones fixed for the whole of the session at their private residences for a charge of 30kr. The offer has been received with much satisfaction, and a large number of the members have availed themselves of it.

There is no doubt that Sweden stands at the head as regards telephonic development, not only in the towns but even in comparatively remote districts. As an instance I may mention the province of Dalarne, where, owing to private enterprise and a good feeling between the different companies, the system has been very generally adopted. Through economical management expenses have been brought down to what may fairly be considered a minimum. In the Falu Telephone Company there is an entrance fee of 200kr. (1kr. = 1s. 1d.), with an annual subscription of but 15 to 20kr. The result is that even people in a very small way of business now use the telephone. That the prices would be very different ones were the telephone in that district in the hands of the State Telegraphs may be taken for granted. Nor does the telegraph in any way suffer through this widespread telephone system. On the contrary, it is the medium of conveying to the telegraph stations a number of messages which would otherwise never have been sent. It seems odd that the telephone is comparatively so little used in England, although business hours are shorter and time of much more value there than on the Continent, and foreigners visiting England cannot quite understand that Englishmen, otherwise so practical, are so much behind the former in this respect.

The corporation of Copenhagen has now published the detailed plan of their new central station. The area to be served by it is intended to have a diameter of about 6,000 feet, so that 3,000 feet will be the greatest distance from the station. As a beginning, machines, &c., will be fixed for the supply of current for 10,000 lamps, but so that it can be increased up to three times this amount. For simultaneously working these 10,000 lamps about 1,100 horse-power has been considered necessary, and the power will be supplied by four steam engines, but there is accommodation for engines up to 3,000 horse-power. The cost of the engine-house, which covers about 6,000 square feet, has been estimated at 75,000kr. The steam-engines, with pumps, fittings, &c., are expected to cost 160,000kr.; the eight dynamos will cost 170,000kr.; water-pipe, &c., 25,000kr. The cost of the boiler-house is calculated at 65,000kr.; five boilers, 103,000kr. An accumulator building large enough to contain a battery of 2,000 lamp-hours' capacity is put down at 10,000kr., and accumulators at 50,000kr. The wires will be copper, protected by concrete or iron casing, and the three-wire system has been decided on. The mains for 10,000 lamps will cost about 480,000kr. As regards later extension, the matter is simple enough as regards engines, boilers, &c., but with regard to the mains it is a different thing, and it has been under contemplation to begin with mains large enough for 20,000 simultaneously burning lamps, which would entail an additional expense of some 220,000kr. This plan has, however, been abandoned, at least for the present. In addition to the above expenses, 57,000kr. will be laid out on alteration of the building, &c., bringing the total up to 1,195,000kr. It is proposed to adopt the originally proposed charge of 8 öre per 100 watt hours (about $4\frac{4}{10}$ öre per 16 candle lamp per hour—1d. = $7\frac{1}{2}$ öre) as a basis, although a somewhat different mode of charging may be actually employed. It has not been thought advisable to leave it to the different consumers to find their own lamps, so that, to begin with, a lamp charge will be made, including a charge for renewal. The charge will be moderate, and it is thought that in time this charge might be abandoned and the lamp question left to the consumers. Lamp renewals have been estimated at $2\frac{1}{2}$-3kr. per incandescent, and it is proposed to fix the lamp charge at 4kr. per annum, including first cost and renewal, which is equal to about one-fifth öre per hour. It is proposed to take the money for this station from the renewal and extension fund of the gas works, which are Corporation property.

CORRESPONDENCE.

COST OF ELECTRIC TRACTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Inferences have been drawn from the recent statement of the Chairman of the North Metropolitan Tramway Company, that in the light of practical experience seem hardly justifiable. I would therefore beg permission to call attention in your pages to the following facts:—In the first place, Sir, it must be borne in mind that that gentleman merely announced that the cost to his own company of electric traction on the Barking-road had been $4\frac{1}{2}$d. per car mile. Of course the ordinary deduction would be that the cost to the Electric Traction Company had been less than this, but considering that several of the companies who are interested in pushing electric traction would be quite willing, in view of the difficulties in the way of making a start in this country, to work a first line at a loss, to say nothing of the chances of their unintentionally doing so, I think it is not too much to say that it is difficult to believe that there can have been any real profit to the Traction Company in the undertaking. I do not mean to say that it is impossible to work by electricity at this cost, as with the overhead conductor, or even with the expensive underground channel (on short lines with heavy traffic), it is perfectly practicable; but I do say that with accumulator systems, such as the one in use on the road in question, it is impossible at this figure to make adequate provision for the maintenance and renewal of the secondary cells employed. For an experiment of six months or so all may look well, but it is certain that at least 30 per cent. per annum must be allowed for depreciation on accumulators subjected to such rough usage (both from an electrical and from a mechanical point of view) as is bound to fall on them when used for electric traction. When one considers that, in addition to this enormous depreciation, the efficiency of the accumulators cannot possibly in practice exceed, say, 70 per cent., it is not difficult to see why the storage battery system must be dearer than the direct supply by a fixed conductor, except in those cases where the line is very long and the traffic light, so that a small return only is secured on the capital laid out on a lengthy conductor.

The truth of this assertion is completely borne out by the only definite figures hitherto published as to the cost of traction by accumulators for any practical length of time, viz., those derived from the working of the Brussels tramway (*The Electrician*, August 16, 1889, p. 386). Here the Julien system has been in use for $2\frac{1}{2}$ years, and the cost of maintaining the accumulators, estimated at about $\frac{1}{2}$d. per car mile, turned out in practical working to be $1\frac{1}{2}$d.; maintenance of motors and gear nearly another 1d., these two items together making nearly $2\frac{1}{2}$d. per car mile, and the total expenses of running, without counting wages, maintenance of engine, depreciation of fixed and rolling stock, and interest on capital, amounted to over 4d. per car mile. Considering that the wages of drivers alone come to about $\frac{1}{2}$d. per car mile, the public are quite justified in believing, until the production of some proof to the contrary, that the $4\frac{1}{2}$d. per car mile charged by the Electric Traction Company, if it represents anything at all, includes only the immediate out-of-pocket expenses, and does not cover a due allowance for maintenance and depreciation.

With apologies for trespassing so far on your valuable space,

Yours, &c., H. J. S. HEATHER.

18, Stanley-road, Wimbledon, February 10, 1890.

MR. KAPP'S REPORT ON THE ARON METER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read with great interest Mr. Kapp's report on the Aron meter, and your remarks on it. As I have had considerable experience of meters of various types, I trust you will pardon me for offering a little criticism on the report in question.

First, let me say there are two obvious misprints. In the direct current test with 23 amperes, the constant should be 1·13

Digitized by Google

instead of 1·30, and in the alternating test with different ∿s it should be 1·195 instead of 1·95.

Passing over these printer's errors, I would ask Mr. Kapp whether he considers a four-fold range sufficient for a meter to be fairly accurate over. There are meters in the market, which for obvious reasons I will not name, that have identical constants at 10 amperes and 100 amperes, or 6 amperes and 60 amperes.

As an instance of what a meter *can* do, I may mention one that has been at work since December 3, 1887, continuously (with the exception of a few days when it was taken out of one consumer's installation and put in at another's), and is still working satisfactorily. The constant was determined at 1·9 amperes, at 95 amperes, and at four intermediate points, and the extreme variation from the mean was 0·1 per cent. This, it will be observed, is a fifty-fold range.

In order that a test should be thoroughly satisfactory, at least five or six points should be determined on the curve connecting current and constant; for it is an easy matter to adjust a meter so as to have the same constant at two given points, but not so easy to get the line joining them straight.

We must hope in the interests of consumers that it is not of importance for the meter to be accurate with varying P.D.'s for a mean pressure whose limits are 95 volts, and 130 volts is not a cheering prospect to any but lamp makers.

As regards the regulation of the Aron meter, it is satisfactory to learn that it is so easy, for I believe it is not impossible for the controlled pendulum to stop, and in a few hours undo the work of many days. I believe it to be a fact well known to clockmakers that no matter how carefully a clock may be regulated when it leaves their hands, it always requires adjusting *in situ*. This applies also, I have been told, to Aron meters, and would appear to be a serious disadvantage, since a considerable time is necessary for a small difference in the rate of the pendulums to show, so that several journeys are necessary for the man installing it; moreover, once an adjustment is altered, one cannot feel certain that the constant determined before the adjustment was made is still applicable. Indeed, Mr. Kapp's report shows the effect on the constant of the adjustment he made.

Apologising for the length of this letter.—Yours, &c.

A. K. C.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning.*]

"THE ELECTRICIAN"

ELECTRICAL TRADES' DIRECTORY & HANDBOOK for 1890

The new edition of our well-known Directory and Handbook is now ready. The book consists of 850 pages, and has entailed this year an exceptionally heavy amount of work. The HANDBOOK DIVISION contains a mass of most useful information. The DIRECTORY DIVISION consists of more than 400 pages, and contains a very carefully compiled Alphabetical and Classified List of Firms and Persons engaged in the Electrical and Allied Trades in all parts of the world. This Division has been corrected up to date, and the book is thoroughly reliable, even the very numerous changes which take place in the month of January being incorporated. By the aid of this Directory, makers of Electrical Machinery, Apparatus, Instruments, Fittings, Sundries, Novelties, and other goods, may safely communicate direct with probable customers without the annoyance and great expense consequent upon using books which are mere lists of Members of Scientific Societies repeated again and again. A large number of copies have been already subscribed for from the Colonies, the Continent, the United States, and other Foreign Countries, whilst at Home orders have been received from Local Authorities, Railway, Tramway, Mining, and other large Industrial Corporations, as well as from those for whom the Directory and Handbook is primarily compiled. The Colonial and Foreign Division will be found extensive and reliable. *Orders should be forwarded at once.*

PERSONAL.—Mr. Holland Dell, for many years secretary to the Electrical Power Storage Company before the amalgamation with the Electric Construction Corporation, has been appointed sole representative for the United Kingdom and Colonies, of the well-known Paris carbon manufacturers, Messrs. Lacombe and Co. Mr. Dell's offices are at 7, Little Queen-street, Westminster, S.W.

MESSRS. WOODHOUSE AND RAWSON UNITED (LIMITED). — This Company are about to wire the premises of the Hansard Publishing Union in Russell-court, and the current will be supplied from the Sardinia-street Station of the Metropolitan Company. In addition to glow lamps, two 30-ampere arcs will be installed to assist in the work of photo-engraving by the Vanoni process.

AWARD.—At the recent International, Electrical, and Industrial Exhibition, held at Birmingham, Messrs. Robey and Co., of Globe Works, Lincoln, were awarded a special first-class gold medal for their high-speed engine fitted with patent electrical regulator.

THE "ELECTRICAL WORLD" OF NEW YORK.—Our enterprising contemporary is circulating in the form of a folio pamphlet an illustrated description of the large new offices recently taken in the Times building, New York. The text of the pamphlet shows that the *Electrical World*, like most technical and trade journals, has had its serious ups and downs, but from the lively way in which the history of the paper is written, and from outward and visible signs generally, we gather that in 1890 the paper continues its successful career. As European agents for the "World," we can speak with some authority of the very considerable sale the paper has in this country and on the Continent, and we feel sure that the enterprise shown in distributing broadcast the interesting particulars above referred to will reap its reward in a considerable addition to its already long list of British and Continental subscribers.

ELECTRIC LIGHT AND POWER RISKS IN AMERICA.—We have received a prospectus of the Electric Mutual Insurance Company of Boston, Mass. From this we learn that it is proposed to organise and incorporate a Company for the purpose of insuring electric light and power generating or distributing stations throughout the United States against loss or damage by fire. The prospectus states that it is difficult to obtain insurance on electric lighting and power property owing to the lack of knowledge on the part of fire underwriters as to the fire hazard of this class of risk, and that a universal demand for insurance at reasonable cost exists throughout America. There are in the United States over 1,000 central stations, with a probable average valuation of not less than £5,000, making an insurable value aggregating £5,000,000. It is proposed to begin with a maximum of £5,000 on a single risk, and reduce that line according as the risk varies from the standard. In New England there are 100 acceptable stations on which it is believed an average of £3,000 insurance will be at once effected. It is proposed to maintain a system of inspection similar to that established by the large fire risk Corporations, and bureaus of inspection will be established in all the large cities of the Union, giving each station as many examinations per year as may be thought advisable by the Directors. For this purpose a sufficient number of skilled inspectors will be employed. In conclusion, the prospectus states that in addition to the expectation of a materially reduced cost of insurance, great benefit will accrue to the owners of electric light and power stations from the periodical visits of competent inspectors, who will be expected to give each Company advice and instruction as to reducing the fire hazard. The prospectus is endorsed by a large number of gentlemen well known in electrical circles in America, including J. F. Morrison, S. A. Duncan, Prof. Elihu Thomson, Thos. A. Edison, Wm. A. Anthony, Otto A. Moses, Allen V. Garratt, Allen R. Foote, C. D. Morse, and about 60 others.

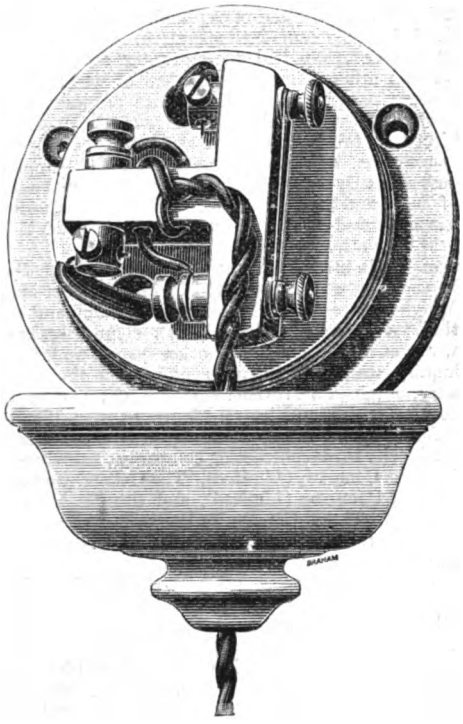
BINSWANGER'S HIGH INSULATION CEILING ROSES.

The use of ceiling roses has become very general for electric light installations of every kind. Both in the factory and in the drawing-room they are employed as the most convenient, safe, and artistic attachment of pendants to the mains. Since they were first introduced, like all other electrical fittings, they have had to undergo a great many changes. A good ceiling rose should be fireproof, easily wired, strong enough for carrying weight, for which purposes no contact pieces should be used, should have plenty of room for a cutout, and the whole construction should be such that dampness of the wall should not affect its insulating properties. The illustration shows the latest type designed by Mr. G. Binswanger, and manufactured by the General Electric Company.

On the top of the china base are walls projecting in the shape of a T, to which the terminals are fixed in such a way that no brass parts of any kind are visible at the back of the ceiling rose. Two holes leading through these walls are for the purpose of separating the flexible wire in the manner shown above, thus making it

Digitized by Google

possible to connect considerable weight to the ceiling rose without strain on any of the contact pieces, while the wire is also separated at the base so as to meet the requirements of insurance companies. The terminals are very substantial, and there is 1¼in. space for the cutout, which is constructed for the use of tin or lead wires with or without eyelets.



The Binswanger Ceiling Rose.

We are glad to see that manufacturers are now paying such great attention to these small fittings, which contribute so largely to the proper working of an electric light installation.

LEGAL INTELLIGENCE.

Blackburn v. the Lancashire and Yorkshire Railway Company.

The above was an action brought before Deputy-Judge Wright in the County Court by R. S. Blackburn, electrical contractor, carrying on business at Hebden Bridge, against the Lancashire and Yorkshire Railway Company for £2. 10s. 1d., for damages alleged to have been caused under the following circumstances.

Mr. SHAW, who appeared for the plaintiff, said that in the month of April last plaintiff undertook a contract for the construction of a telephone line at Newhey, near Rochdale, and about 22 miles from Halifax. For the purpose of the work he ordered from a firm of wire manufacturers in Halifax, a quantity of copper wire with instructions to forward to Newhey railway station. This wire, which was required on the following morning, was despatched from Halifax on the 24th of April, but was not delivered until the 27th. The result of this delay was that a number of men engaged by the plaintiff were unable to proceed with their work, and expense was incurred in railway fares, wages, &c., the total amounting to the sum now claimed. Mr. Shaw contended that this delay was unreasonable for such a distance of transit. In fact, if it had not been for the negligence of the company's servants in miscarrying the wire to Oldham instead of placing it down at Newhey station, as addressed, the goods would have been delivered at the proper time.

Mr. STOREY (who represented the Lancashire and Yorkshire Railway Company) for the defence said that the goods in question were sent at "owner's risk," and at the lowest freight. He contended that no negligence on the part of the defendant company had been proved, and as the goods had to be twice transhipped, the delay was not unreasonable. He contended that it would be monstrous to saddle a railway company with damages under such circumstances as those.

The DEPUTY JUDGE thought there was not sufficient evidence of negligence to entitle plaintiff to a verdict. It was true the goods were sent at "owner's risk," that was at the lowest rate at which goods were carried; but if he had been satisfied that there had been negligence, the fact that the goods were sent at "owner's risk" would not have prevented him from giving a verdict for the plaintiff. Although the goods were a long time in transit for so short a distance, there was no evidence of negligence, and the delay, for anything he knew, might have arisen from an accident or a mistake in transhipment. There would be a verdict for defendants.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

January 18, 1890.

941. A. L. LINEFF and E. H. BAYLEY. London. Improvements relating to electric tramways and tramcars.
950. W. THOMPSON. London. Improvements in dynamo machines.
962. J. SWINBURNE. Wimbledon. Improvements connected with cars worked by electric accumulators.

January 20, 1890.

993. J. W. EDMUNDSON and W. CLARKE. London. Improvements in holders for incandescent electric lamps.
1,026. W. S. BOULT. Birkenhead. Improvements in or relating to automatic accumulator switches.

January 21, 1890.

1,028. W. P. THOMPSON. Liverpool. A new or improved method of converting a direct or continuous electric current into an alternating current, and improvements in or relating to apparatus therefor (L. Gutmann, United States).
1,031. J. VON PEICHL. London. Electric compass and course recorder.
1,037. R. C. M. BOWLES. Glasgow. Improvements in mechanical telephones.
1,050. C. BOLLE. Manchester. Improvements in dynamo electric machines and electric motors (L. Gutmann, Pennsylvania).
1,068. G. B. LÜCKHOFF and E. H. HUNGERBÜHLER. Croydon. Improvements in dynamo or electro motor conductors.
1,072. G. BINSWANGER. London. Improvements in electrical switches.
1,094. H. H. LAKE. London. Improvements relating to secondary or storage batteries (T. Ewing, United States).
1,106. H. H. CARPENTER. London. An improved system of electrical distribution.
1,110. C. A. HITCHCOCK. London. An improvement in galvanic batteries (W. Burnley, United States).

January 24, 1890.

1,280. C. L. BAKER. Hammersmith. Improvements in switches used for electrical purposes.
1,281. V. H. ERNST. London. Improvements in secondary batteries. (Date applied for under Patents Act, 1883, Sec. 103, September 28, 1889, being date of application in United States.)
1,302. A. P. TROTTER. Improvements in means or apparatus for facilitating calculations relating to the supply of electrical energy.
1,306. C. SMITH. London. Improvements in galvanic dry-elements (W. L. F. Hellesen, Denmark).

January 27, 1890.

1,391. W. BALCH. London. An improved electric firing battery and cells.

January 28, 1890.

1,495. H. H. LAKE. London. Improvements relating to storage batteries or accumulators (G. A. Johnson, United States).
1,516. J. E. SPAGNOLETTI and J. CROOKES. London. Improvements in electric light fuses or cut-outs.
1,529. J. D. TAYLOR. London. Improvements in electric signalling apparatus.
1,530. J. W. T. OLAN. Marstrand. Improvements in measuring of electric currents and an apparatus connected therewith.

January 29, 1890.

1,534. G. WILKINSON. Improvements in driving gear for electrically-propelled cars or vehicles.
1,554. G. CAFIERO. Gloucester. An electrical head-piece and reins combined for preventing restive horses and other animals running away.
1,555. G. W. ELLIOT. Sheffield. An improved magnetic separator.
1,559. H. C. BLACKWELL. Manchester. A combined ceiling rose cut-out and switch for electric lighting purposes.
1,596. H. H. LAKE. London. Improvements in electric lamps or lighting apparatus (F. C. Jenkins, Germany).

January 30, 1890.

1,618. J. M. G. TREZISE. London. A method of and means for automatically breaking and making an electric circuit.

SPECIFICATIONS PUBLISHED.

1888.

1,166. LOWRIE and HALL. Testing electric conductors. (Price 8d.)
2,544. DOUGLAS and SMITH. Secondary batteries. (Price 6d.)
2,567. ELWELL and STARLEY. Electrically driving vehicles. (Price 8d.)
3,402. SCOTT and others. Metering electric energy. (Price 8d.)
3,844. THOMPSON (Westinghouse Electric Company). Electrical distribution. (Price 8d.)

Digitized by Google

4,875. IMMISCH. Electrical transmission. (Price 6d.)
4,883. HOWARD. Electrical switch. (Price 6d.)
6,063A. LAKE (Thomson). Electric spark rupturing appliances. (Price 8d.)
11,661. HUELSER (Mestern). Thermo-electric batteries. (Price 8d.)
16,148. STUDTE. Electric couplings. (Price 6d.)
19,892. FOWLER. Welding metal by electricity. (Price 6d.)

1889.

656. DENES and GATWARD. Measuring electric currents. (Price 6d.)
1,038. REES. Electric lamps. (Price 8d.)
1,430. WRIGHT and others. Electric meters and motors. (Price 11d.)
2,168. THOMPSON (Tudor). Electric meters. (Price 8d.)
2,313. LAWRENCE. Applying electricity. (Price 8d.).
2,331. DOWLAND and another. Decomposing substances by electricity. (Price 6d.)
3,580. BERRY. Electric bell. (Price 6d.)
3,907. PARKER and REES. Electrical switches. (Price 6d.)
4,192. SIEMENS BROTHERS and Co. (Taylor). Regulator for transformed electric currents. (Price 6d.)
6,063. LAKE (Thomson). Safety device for electric circuits. (Price 8d.)
12,286. Sir C. S. FORBES. Electric current meter. (Price 8d.)
18,004. SLOAN (Wilson and Brown). Incandescent electric lamps. (Price 6d.)
18,979. MICHL. Electric current regulator. (Price 6d.)
19,004. WHITE. Electric glow lamps. (Price 6d.)
19,216. PATTEN. Generating, &c., electric currents. (Price 8d.)
19,420. LAKE (Tesla). Alternating-current electro-magnetic motors. (Price 6d.)
19,426. LAKE (Tesla). Alternating-current motors. (Price 8d.)
19,484. ANDERSEN. Electric switches. (Price 8d.)
19,661. LOGAN. Secondary batteries. (Price 8d.)
19,661A. LOGAN. Secondary batteries. (Price 6d.)
19,883. PUMPELLY and THOMASON. Electrical secondary batteries. (Price 8d.)
19,899. THOMPSON (Parrish). Electric batteries. (Price 6d.)

Second Edition.—1884.

6,734. PARSONS. Electric generators. (Price 8d.)

COMPANIES' MEETINGS & REPORTS.

Chelsea Electricity Supply Company (Limited).

The ordinary annual general meeting of this Company will be held at their Central Station, Draycott-place, Sloane-square, London, S.W., on Wednesday the 19th inst., at 12 o'clock noon, at which the following report of the Directors will be presented :—

Up to May, 1888, when the last report was issued, the Company had only been able to take preliminary steps for its development. In July of that year the Electric Lighting Bill, introduced to Parliament by Lord Thurlow, having passed both Houses, the Board of Directors was re-formed, and a prospectus was published. The capital requisite to proceed with the construction of a generating station, and to put down the necessary plant for the distribution of electricity within the first area of supply, as included in their Act, was then obtained. The necessary contracts for building and plant having been made, work was commenced in the latter end of 1888, and in an unprecedentedly short time the central station was completed, under the supervision of the Company's architect, Mr. F. G. Knight, of 6, Great College-street, Westminster.

Early in April, 1889, the station was so far ready that experimental plant was put to work, but owing to a delay in supplying the engines arising out of the destruction by fire of the works of Messrs. Willans and Robinson, of Thames Ditton, and several other causes, the period of experiment and preparation continued until the end of September, after which the work of regular and extended supply came into operation.

At the outset the Company had to encounter competition within its area of supply of two other Companies, neither of which were operating under Parliamentary powers. These Companies proposed to invade the district with overhead lines, and take advantage of the uncertainty of the law on the subject to obtain some custom at a comparatively small outlay. By strenuous opposition, by actively pushing on the completion of its works, and by subsequently entering into a friendly arrangement (approved by the Board of Trade and the Chelsea Vestry) with one of those Companies, the Company has succeeded in neutralising any effect which this desultory competition might have otherwise had on its business.

At the Board of Trade inquiry held at Westminster Town Hall in March and April, 1889, the Company, represented by Mr. Fletcher Moulton, Q.C., and Mr. R. S. Wright, successfully defended its position, and succeeded in showing that the system it had adopted, now commonly known as the Chelsea system, was at least equal to any other system under inquiry. One result of this inquiry was, that the Company, with the consent of the Kensington Vestry, obtained a Provisional Order for a part of that parish, known as the South Kensington Electric Lighting Order, 1889.

The contracts for the plant to extend the system into Kensington, were again undertaken by the three contracting companies, namely :—The Brush Electrical Engineering Company (Limited), The Callender's Bitumen Telegraph and Waterproof Company (Limited), and the Electric Construction Corporation (Limited). These Companies agreed to receive payment in fully paid-up shares of the Chelsea Company. Since early in December current has been supplied in South Kensington.

The Company has obtained the sanction of the Board of Trade, and of the Chelsea Vestry, to extensions of their area of supply on the south, and on the north of their first area up to Knightsbridge, including the Lowndes-square district. They have nearly completed the erection of a fourth storage station at the northern end of Pavilion-road, and have made all the arrangements for laying down the necessary mains throughout those areas.

In the erection of the Company's central station, the Directors were obliged to provide a building of sufficient capacity for all probable future demands and extension of area of supply. The building includes space for a generating plant to supply a total of 30,000 (8 to 10 candle-power) lamps in use at one time, representing a total of 60,000 installed. Besides, it contains one storage station, the necessary offices, and residential accommodation for some of the staff. The outlying storage stations of the Company in use, or about to be put to use, are in Clabon-mews, Pavilion-road, and Egerton-gardens, and negotiations are in hand for a fourth.

The Company has received many testimonials from its customers, expressing the most marked approval of the system of supply. The causes for this satisfaction continue, and they may be chiefly traced to the perfect steadiness of the light, and the consequent economy of wear and tear of glow lamps, and total absence of any interruptions to the light which the system secures.

The steady and gratifying growth of the Company's business is exemplified by the following statement showing actual cost (exclusive of general charges) of running machinery and storage stations, and the revenue received for current supplied during the three months ending December 31, 1889. The table shows the relation between running and revenue expenses in the months of October, November, and December, 1889, being the first regular quarter, and bears remarkable evidence of the proportionate increase of income, as compared with expenses as custom extends.

PATENT
SILICIUM BRONZE AND SILICIUM COPPER WIRE.
The best for overhead Telephone and Telegraph Lines,
AND ALL ELECTRICAL PURPOSES.
Hard Drawn High Conductivity Copper Wire.
ROLLED AND DRAWN
PHOSPHOR BRONZE.
PHOSPHOR BRONZE
PHOSPHOR BRONZE
VULCAN PHOSPHOR
DURO METAL
PHOSPHOR BRONZE
BEARINGS, BUSHES,
AND OTHER PARTS OF
ELECTRICAL MACHINERY.
SOLE PROPRIETORS of the British, Indian and Colonial Patents,
THE PHOSPHOR BRONZE COMPANY (Limited),
87, Sumner Street, Southwark, London, S.E.
WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

Digitized by Google

Expenditure:—

October—Coal, water, oil, waste and wages, removal of ashes and fitters time	£82	0	10
November " " " "	114	14	0
December " " " "	141	9	6

Income:—

October—Current invoiced	£146	1	6
November " "	262	8	2
December " "	405	12	0

In order to complete the works in hand, and to be ready to meet the cost of the necessary extensions, the Directors seek the approval of the shareholders to the creation of debentures to the amount of £50,000.

The retiring Directors are Major-General Webber and Mr. Daniell. who, being eligible, offer themselves for re-election. The auditors, Messrs. Cooper Brothers & Co., also offer themselves for re-election.

The following resolution will be proposed at the meeting:—

"*That the Directors be, and they are hereby, authorised to borrow a sum not exceeding £50,000, and to secure the same by the issue of Debentures in such form, secured in such manner, and issued to such persons on such terms and at such times as the Directors may deem expedient.*"

NEW COMPANIES REGISTERED.

THE ELECTRICAL ENGINEERING CORPORATION.—The prospectus of this Company has been issued this week. As our readers are aware, it is an amalgamation of the firms of J. G. Statter and Co. (Limited) and the United Electrical Engineering Company (Limited). The capital is £150,000, in 29,600 ordinary shares of £5 each, 400 founders' shares of £5 each, and £20,000 in 200 Six per Cent. Mortgage Debentures of £100 each. The present issue is £77,000, in 15,000 ordinary and 400 founders' shares of £5 each, of which 15,000 ordinary shares are now offered for subscription at par, together with £20,000 Six per Cent. Mortgage Debentures, as a first charge. The electrical engineer is Mr. Sydney Linton Brunton, Assoc.M.Inst.C.E., Assoc.M.Inst.E.E., and the secretary Mr. Percy E. Scrutton.

FAREHAM ELECTRIC LIGHT COMPANY (LIMITED).—The prospectus of this Company was issued yesterday (Thursday). The capital is £5,000 in £1 shares, of which 1,600 are offered for public subscription, payable 5s. on application, 5s. on allotment, and the balance as may be required, subject to one month's notice. The directors are S. R. Delme, Esq., Cams Hall, Fareham; Capt. J. Ramsey, R.E., Yvery House, Fareham; Admiral S. P. Townsend, Osborn-road, Fareham; James Blake, Southfield House, Fareham. On the completion of the company the shareholders will be asked to elect three directors. The Laing, Wharton and Down Construction Syndicate are the electrical engineers. The prospectus states that the Company is formed for the purpose of supplying electricity both for public and private lighting, and also for motive power in the town of Fareham and its vicinity. It is proposed to use the Thomson-Houston system. The list of applications for shares opens on Monday next, and close on Monday, March 3.

LANE FOX ELECTRICAL COMPANY.—OBJECTS: To carry on the business of electrical engineers, electricians, practical engineers, contractors and manufacturers of apparatus for producing and supplying light, heat, sound, and power by electricity or magnetism. Capital £100 in £1 shares, which are fully subscribed for by St. George Lane Fox, electrical engineer, 50, South Eaton-place, 70 shares; Charles Arthur Stephenson, electrician, 90, Inverness-terrace, 2; Walter John Grove, J P., Salisbury, 2; Bernard Drake, electrical engineer, 60, Victoria-street, Westminster, 5; John Marshall Gorham, electrical engineer, 66, Victoria-street, 5; William Lane Fox Pitt, 4, Grosvenor-gardens, 12; and F. J. Cobden Sanderson, barrister, Hendon. Vote per share. First directors (three to ten), the subscribers above-named. Remuneration £1 each per attendance, and 7 per cent. of profits available for dividend to be divided proportionately. Borrowing limit, £5,000. Registered February 6th, by Waterlow Brothers and Layton (Limited), Birchin-lane.

THE MUTUAL TELEPHONE COMPANY (LIMITED).—Registered by Rowcliffes, Rawle and Co., 1 Bedford-row, W.C., with a capital of £100,000 in £10 shares. Object, to carry on any business relating to telephones or telephone apparatus, or any business which may be advantageously carried on therewith. The first subscribers are:—W. D. Provand, 9, Bridge-street, Westminster; G. Hahle, 100, Portland-street, Manchester; H. T. Gaddum, 57, Brown-street, Manchester; E. Guthrie, 71, King-street, Manchester; W. Thomson, 79A, Princess-street, Manchester; W. Mallison, 105, Princess-street, Manchester; E. A. Hague, 6, Dickinson-street, Manchester; W. Wadsworth, 4, Albert-square, Manchester; A. Forrest, Hoet Town, Manchester. There shall not be less than five nor more than 15 Directors, the first to be appointed by the subscribers to the memorandum of association. Qualification, 10 shares. Remuneration to be determined in general meeting.

UNIVERSAL ELECTRIC LIGHT AND POWER TRUST CORPORATION.—Objects: To invest moneys in and acquire shares, stock, debentures, and securities of any company, trust, or corporation at home or abroad, and in particular such as pertain to the supply of electric light, heat, or power for public or private purposes, and to promote and assist enterprises of a cognate character. Capital, £5,000, in £10 shares, of which 400 are founders' shares, the remaining 100 being ordinary. Founders' shares to receive one moiety of surplus net profits, after 8 per cent. dividend. Registered, January 28, by T. H. Harvey-Samuel, solicitor, 1, Whittington-avenue.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended February 7th amounted to £5,014.

BRUSH ELECTRICAL ENGINEERING COMPANY.—In view of the satisfactory volume of business transacted during the past six months, the Directors of this Company have decided to pay an interim dividend upon the preference shares of this Company, and warrants for a dividend on these shares at the rate of 6 per cent. per annum from August 10, 1889 (the date of registration of the Company), to February 10, 1890, will be issued on the 1st proximo. As the books of the Company will not be made up until the close of the year, the Directors defer the question of a dividend on the ordinary shares until the complete accounts are before them. The transfer books of the Company as regards the preference shares will be closed from the 15th inst. until the 1st proximo.

ELECTRICITY SUPPLY COMPANY OF SPAIN.—There is a call due this day (Friday) of 30s. per share on 19,900 shares of this Company.

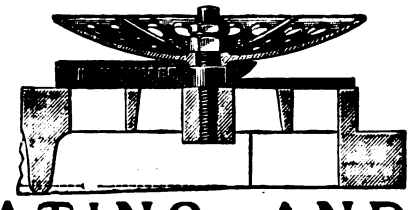
SHANGHAI ELECTRIC COMPANY.—The new Shanghai Electric Company (Limited) has paid a dividend of 7 per cent. for the year ended October 31st last—the first year of its working.

TAUNTON ELECTRIC LIGHTING COMPANY.—At the annual meeting of this Company held on Monday, the 3rd inst, at the Castle Hotel, Taunton, the Chairman moved that the report be adopted, and that a dividend of 5 per cent. free of income tax, be declared. He said that early in the year the Directors gave their careful consideration to the procuration of a new site for their depôt, and they secured by public auction a piece of land, situated very near to the Gas Company, but owing to the recent disastrous flood, which rendered their purchase useless, they went to considerable expense in building arches upon which to erect machinery. Under these circumstances they had bought a piece of land which, he believed, would serve their purpose admirably, being in nearly the centre of the town. They had now nearly completed their depôt, and the shaft was a land mark which could be seen a long way round Taunton, serving as a valuable advertising medium. The work of laying down the machinery was in progress, and they hoped in two or three weeks they would be in full working order.—The report was adopted, and Mr. Fowler, Mr. C. E. Lance, and Major Winter were re-elected Directors.—Mr. Down (of the firm of Laing, Wharton, and Down) stated that his firm last week got the contract for lighting one-half of the streets of London and the monopoly of private lighting. He expected they would get the contract the next day for lighting another town about as large as Taunton. He congratulated the Company upon the valuable site they had secured.—Mr. Massingham proposed that "in future years the annual general meeting of the Company be held any time during February that the Directors might think fit," which was carried. A vote of thanks terminated the proceedings.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended February 7th, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,804.

NEW VALVE

No Rubber, Percha, or Leather.



One-half the price of Rubber or Metal.

FOR CIRCULATING AND AIR PUMPS.

Unaffected by any Lubricating Oils. Does not Expand in diameter. Feed Water may be worked at any temperature Suitable for any shaped guards. Only one quality manufactured.

"12, John-street, Sunderland, 26th Sept. 1885.

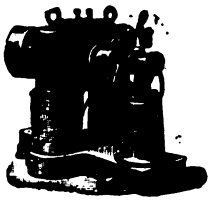
"DEAR SIRS,—In reply to your letter of the 25th inst., the Valves I got from you have done their work well, and ARE AN UNQUALIFIED SUCCESS. I will continue to get them from you as required.—Yours faithfully, JAMES WESTOLL."

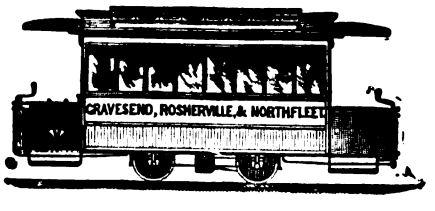
For further Testimony and Prices, apply to **MOSSES & MITCHELL, 68-71, Chiswell Street, London.**

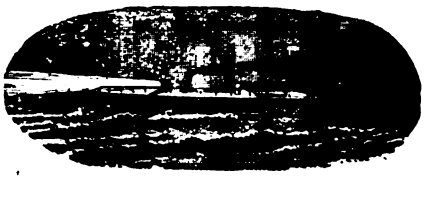
Digitized by Google

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Wednesday, Feb. 12, 1890.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending Feb. 12, 1890.	
£			**TELEGRAPHS.**		£ s. d.		Highest.	Lowest.
1,770,360	Stock	12/6	Anglo-American	51 52	5 5 9	Jan., Apr., July, Oct.	51½	51
2,614,820	Stock	25/0	Do. Preferred	87 88	6 5 0	,, ,,	87½	86½
2,614,820	Stock	...	Do. Deferred	15 15½	...	February	15⅝	15
130,000	£10	3/0	Brazilian Submarine	12 12½	6 0 0	Mar., June, Oct., Dec.	...	...
112,900	£100	5%	Do. 5 per Cent. Bonds	99 101	4 19 0	January and July	...	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	104 107	4 13 6	June and December.	...	...
16,000	10	9/0	Cuba Submarine	12 13	6 18 6	February and August	...	...
6,000	10	10%	Do. Preference 10%	19½ 20½	4 19 9	,, ,,	...	...
12,931	5	2/0	Direct Spanish (£4 paid)	¼ ½	4 8 11	March & September	...	...
6,000	5	10%	Do. Preference 10%	9 10	5 0 0	April and October	...	...
60,710	20	3/6	Direct United States	10 10½	6 16 7	Jan., Apr., July, Oct.	10 1/16	10
380,000	10	2/6	Eastern	13⅞ 14½	4 12 0	,, ,,	14 1/16	13 15/16
70,000	10	6%	Do. 6 per Cent. Preference	14¼ 15¼	3 18 8	,, ,,	14⅞	14⅜
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock	105 107	3 14 9	May and November.	107	10 5/16
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	106 109	4 11 9	February & August	107	...
250,000	10	2/6	Eastern Extension	13⅞ 14	4 12 10	Jan., Apr., July, Oct.	14	13⅞
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	100 102	5 17 8	February & August	...	...
473,000	100	5%	Do. 5 per Ct. (Austrln. Gov. Sub.) Debs. 1900	102 105	4 15 3	January and July	...	...
179,177	10	1/9	Globe Telegraph and Trust	8⅝ 8¾	5 15 6	Jan., Apr., July, Oct.	8¾	8⅝
178,992	10	6%	Do. 6 per Cent. Preference	14⅜ 14½	4 1 4	,, ,,	14½	14⅜
150,000	10	5/0	Great Northern	15½ 16	4 13 9	Jan., July, and April	15 15/16	15⅝
17,000	25	12/6	Indo-European	40 42	5 19 1	April and October	...	...
9,000	8	4/0	Reuter's	7 7½	5 6 5	April and October	...	...
15,609	10	3/6	West African Telegraph	9½ 10½	...	...	...	...
300,000	100	5%	Do. 5 per Cent. Debentures	99 102	4 18 0	March & September	101½	...
30,000	10	5/0	West Coast of America	10⅜ 11¼	...	January and July	10⅞	...
150,000	100	8%	Do. Debentures 8%	119 124	6 9 1	June and December	123	...
88,321	10	nil.	West India and Panama	3⅛ 3⅜	...	...	3¼	3
34,563	10	12/0	Do. 1st Preference 6%	11⅛ 12	...	April and October	11⅞	11⅝
4,669	10	10/0	Do. 6 per Cent. 2nd Preference	14½ 15½	3 17 5	...	...	...
45,181	15	6/0	Western Brazilian	10 10⅜	...	May & November	10½	10
$1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	118 122	5 14 9	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	102 104	5 15 5	March & September	...	...
			TELEPHONES.					
224,850	14/0	5%	Consolidated Telephone and Maintenance	1/16 1⅛	...	Yearly	...	...
220,000	£1	3%	Oriental (11s. paid)	7/16 7/16	3 5 11	...	...	...
80,000	5	6%	National	5⅛ 5⅜	...	June and December.	5½	5⅛
55,000	5	3/0	United River Plate	4⅝ 5⅛	...	January and July	4⅞	...
			ELECTRIC LIGHT.					
500,000	10	...	Metropolitan Electric Supply (£5 paid)	5½ 5⅝	...	...	...	...
79,934	5	6%	Swan United (£3. 10s. paid)	5 5½	3 16 5	...	...	...
			MISCELLANEOUS.					
37,350	12	12/0	Telegraph Construction and Maintenance	45 47	5 2 3	March and July	45½	...
41,600	10	10/0	India Rubber, Gutta Percha & Telegraph Works	18½ 19½	5 2 7	February & August	19 3/16	18⅞







Before Ordering!

ELECTRICAL PLANT & ACCESSORIES

WRITE FOR THE FOLLOWING PAMPHLETS TO THE

UNITED ELECTRICAL ENGINEERING CO., Ltd.

Head Offices: 3, Princes Mansions, VICTORIA ST., WESTMINSTER.

"ELECTRICAL DISTRIBUTION."—Commercially considered, with Estimates.

"MACHINE DRIVING BY ELECTRICITY."—The Uses of Electro-Motors for Traction and Stationary Purposes.

"THE TELPHER SYSTEM OF CHEAP TRANSPORT," for Minerals, Goods and Passengers.

"ELECTRICAL SUPPLIES."—Prices and Particulars of the most approved Electrical Appliances

ELECTRICAL PLANT ON VIEW.

Digitized by Google

THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 614.—Vol. XXIV. FRIDAY, FEBRUARY 21, 1890. Price Fourpence.

NOTES.

Mr. Swinburne's Paper on "The Theory of Armature Reaction in Dynamos and Motors," read before the Institution of Electrical Engineers on the 13th inst., will be discussed conjointly with Mr. Esson's communication on "Some Points in Dynamo and Motor Design," read last night.

The simplicity introduced into dynamo and motor design, by considering the subject from the magnetic circuit point of view first suggested by Hopkinson and Kapp, has received fresh exemplification in Mr. Swinburne's valuable Paper. The analogy between the electric and magnetic circuits is still further brought out by the use of the term magnetic potential. The magnetic circuit can thus be considered in parts, just as the currents in each branch of a network of conductors can be determined separately when the electric potentials and resistances are known. The investigation of magnetic leakage is thus rendered clearer. There is, however, no justification for using the erg as the unit of magnetic potential.

The reaction of the armature on the field is very simply described by resolving it into two components, one of which opposes the field by creating a back-induction, while the other creates a cross-induction. In this way the weakening effect on the magnetism of parts of the pole-pieces and its strengthening effect on others is shown in a simple and novel manner. An explanation is also given of the greater amount of sparking occurring at the lower brush of single-magnet Gramme machines.

Mr. Swinburne is probably right in considering that one of the greatest problems yet remaining in the construction of direct-current dynamos is how to avoid sparking at the brushes and the consequent wear of the commutator. In order to avoid the sparks due to the currents maintained in the coils by self-induction, Mr. Swinburne suggests several means for introducing extra electromotive forces opposing the self-induced ones. The confident remarks of the author with regard to the relations between dynamos and motors will certainly arouse a great deal of discussion, as much difference of opinion exists on this point among the best judges, both practical and theoretical. The divergences from perfect reversibility of dynamos and motors are mainly due to the complex armature reactions, and whether these are of much relative importance or not depends chiefly upon the dimensions of the machine.

In connection with the subject of magnetic potential, we may remind our readers that a very simple and convenient instrument for its measurement was described before the Physical Society of London some time ago by Mr. A. P. Chattock. This instrument consists of a long solenoid of many turns wound on an elastic core so as to be flexible. One end of this helix is kept fixed while the other is moved quickly between the two places whose difference of magnetic potential is required. The ends of the coil are connected with a ballistic galvanometer and the impulse imparted to the needle is a measure of the potential difference required. This instrument might be useful in measuring the quantities referred to by Mr. Swinburne, and it seems clear that some such instrument would be of use in dynamo tests and in dynamo design.

The twenty or thirty persons who comprised Mr. Henniker Heaton's audience at the Society of Arts on Tuesday afternoon were evidently too deeply concerned with the cheapening of ocean postage rates to pay much heed to his theories concerning telegraph cable rates, or to criticise too nicely the manner of his advocacy. People, however, who can be got to a five o'clock meeting of that kind are mostly enthusiasts, and may perhaps be excused for patiently, though silently, listening to Mr. Heaton's malignant insinuations against unnamed opponents. The Chairman was apparently the only person to realise the compromising position in which the reader of the Paper was placing the Society. Addressing the meeting at the conclusion of the discussion, Sir Francis Bell remarked that it was not to be expected that all would agree with views put forward on that platform, but so long as they were expressed with moderation and fairness, the Society was always ready to give them a hearing.

We cannot help thinking from this and other indications that the Chairman's ideas of moderation and fairness had been somewhat shocked by various passages in Mr. Heaton's address, and we shall be much disappointed if some of them are not eliminated before the Paper gets published in the Society's *Journal*. The Society cannot guard against its privilege being abused, once at least, by a reckless and intemperate orator, but it can prevent its *Journal* being made the medium for disseminating his gratuitous slanders. What he said of the Post Office and its principal officials was bad enough, and would hardly have been tolerated even in the House of Commons; but of the cable companies, especially of

Digitized by Google

one of them, and of the leading man amongst them, Mr. HENNIKER HEATON'S language, if not the result of that stupid vanity which mistakes extravagance for eloquence, must have been dictated by pure malevolence. Mr. HEATON may consider himself lucky that he had not a larger and more discriminating audience; and we shall be much surprised if he is ever again allowed the chance of addressing one, great or small, at the SOCIETY OF ARTS.

IN the *Electrical World* for February 1st is described an arrangement devised by Mr. MARK DEWEY for operating a series traction system without the necessity for breaking the main circuit. The motor on the car is shunted to a portion of the working conductor, the current from which is diverted into the car by means of an opposing E.M.F. set up in the part of the wire shunted. This E.M.F. is caused by a thick cylindrical iron tube, laminated to avoid eddy currents, and carried by the car so as to be concentric with the working conductor. A longitudinal slot is made in the lower part of the cylinder so as to allow the supports of the working conductor to pass through as the car moves on. Flexible iron or steel brushes are fixed to the sides of the slot, and close the magnetic circuit of the tube by pressing together. The magnetic resistance is thus small, and as alternating currents are employed, a large amount of impedance arises in the portion of the conductor within the tube. We presume that, when the car stops, the motor is short-circuited, so that the impedance caused by the tube does not affect the main current. Alternate-current motors are preferred by the inventor, although others may be used if the alternate current is first rectified by any of the "simple well-known devices" for the purpose. What these simple methods are we should be glad to know. Ingenious as Mr. DEWEY'S method is, it hardly seems to be capable of diverting sufficient power into the car without the employment of iron tubes which would be too heavy for practical work. The arrangement may, in some respects, be compared with a transformer with only half a turn in the primary circuit, and the weight of such a converter designed to absorb power enough to drive a car would be prohibitive.

IN a somewhat lengthy letter in *The Times* of Monday, Major FLOOD-PAGE insists upon two elementary facts which have of late been somewhat lost sight of, namely, that no known system of artificial illumination is absolutely free from danger, and that a consumer who entrusts his indoor wiring to a bellhanger or upholsterer will probably consume his house rather than the electric current. As Major FLOOD-PAGE further points out, the concentration within a single State, and almost within a single city (New York), of so many of these sad fatalities tends to prove that they are due to bad work and not to any inherent danger in the electric light itself.

THE current number of the *North American Review* contains a short article from the pen of Sir WILLIAM THOMSON dealing with the overhead wire question both from the point of view of possible danger and supposed ugliness. After briefly glancing at the question as it presents itself abroad, Sir WILLIAM THOMSON states it as his opinion that if the Board of Trade regulations could be *permanently* fulfilled in every case, the protection of the public would be effectually secured. The trying nature of the English climate, however, makes the permanent maintenance of a high standard of safety sufficiently problematical, he thinks, to warrant the burying of electric light wires at least in city districts. "As for the country, telegraph, telephone, and electric light conductors must all be in the air. The cost of placing them underground would be absolutely prohibitory of the great public benefit to be obtained by placing more and more of them in the air."

IT is needless to say that Sir WILLIAM THOMSON has but scant sympathy with those "persons of taste" who find something unspeakably ugly in the "cirrus clouds of electric wire hovering perennially over the streets and houses," and he prophesies that some future RUSKIN will wax enthusiastic over the beauty of "the gossamer lines of telephone wire . . . ornamenting whatever they touch."

THE rival claims to the invention of the electro-magnet evidently contain the germs of an international imbroglio. "It seems," says *La Lumière Electrique* in its last issue, "that at the Cantor lecture delivered before the Society of Arts on February 3rd, Prof. SILVANUS THOMPSON claimed for STURGEON the honour of having invented the electro-magnet, and it seems that STURGEON exhibited a model of his invention to the Society of Arts in 1825. This claim cannot be sustained for an instant, the invention having been announced by AMPÈRE in September, 1820, before the Académie des Sciences, at Paris, after a communication by ARAGO. We shall return to these pretensions when the full report of Prof. SILVANUS THOMPSON'S lecture is in our hands."

Series Incandescent Lighting.—Mr. Alexander Bernstein has obtained a contract for the lighting of the small village of Farmsen, near Hamburg.

The Series Electrical Traction Syndicate (Limited).—This syndicate have now on hand six provincial contracts for working tram lines by electricity.

Electro-Harmonic Society.—The next concert (ladies' night) of this society will take place on Friday evening next, at the St. James's Hall Restaurant, at eight p.m. The usual excellent programme is provided.

Another Fire at the Pearl-street Station.—A Reuter's telegram in the *Daily News* of Monday states that a slight fire occurred on Saturday last at the works of the Edison Electric Light Company in Pearl-street.

Weybridge.—Several of the residents of Weybridge visited the works of the Laing, Wharton, and Down Electric Construction Syndicate last week, when the electric light was tested for the first time. All were favourably impressed.

A Carbon Disc Arc Lamp.—It is reported from Boston, U.S., that the firm of Heymann Brothers are introducing an arc lamp having rapidly rotating carbon discs in lieu of rods. It is claimed that these lamps can be run for over 40 hours without requiring carbon renewals.

Personal.—Mr. W. J. Hancock, M.I.E.E., Assoc.M.Inst.C.E., Superintendent of Telephones in the Railways Department of

Digitized by Google

Western Australia, has been appointed Superintendent of Telegraphs and Telephones in the Postal and Telegraph Department of Western Australia.

Ipswich.—At their last meeting the Town Council decided to support the Provisional Order promoted by the Brush Electrical Engineering Company. From the report of the Committee it would appear that the Brush Company intends to adopt the low tension system.

Royal Humane Society Awards to Electricians.—The Royal Humane Society has granted its honorary testimonial to Mr. A. E. Saul, third officer, and to Mr. Brown, quartermaster, of the telegraph ship "Buccaneer," for rescuing a sailor from drowning in Pernambuco harbour.

Magdeburg.—The Mayor of Magdeburg invites tenders for the erection of a central station for the distribution of light and power. Tenders must be received by May 1st, at the offices of the Gas und Wasserwerke, Spiegelstrasse 16, Magdeburg, where further particulars may be had.

An American Re-invention.—The *Electrotechnische Zeitschrift* publishes at some length a description of a "new coreless alternator," of the American Brush Company's "patent Pfannkuche." To illustrate it, however, they use three cuts of the Mordey machine, but make no mention of that gentleman.

The Schanschieff Portable Electric Lamp.—At the Königin Luise Colliery, in Upper Silesia, the Schanschieff portable primary-battery electric lamp has been tried with success. The lamp weighs 3·3lb. when uncharged, and 4·6lb. when charged, costs 30s. 6d., and costs about 1d. per hour when burning.

Messrs. Siemens and Halske.—The business of Siemens and Halske has been formed into a company, with Messrs. C. H. Siemens, at St. Petersburg, and A. W. von Siemens and G. W. von Siemens, at Berlin, as responsible directors. Offices will also be taken at Munich, principally for electric light business.

Birmingham.—At a meeting of the Electric Lighting Sub-Committee of the City Council, held on Thursday last week, it was decided to support the Birmingham Electric Supply Company, which proposes to introduce the same system as that in use at Liverpool. It was also decided to oppose any application by another company.

Folkestone.—At the last meeting of the Town Council a letter was read from Messrs. Crompton and Co., to the effect that they would undertake to transfer their Provisional Order to the Corporation on being paid their expenses up to date, viz., £225. After some discussion the matter was adjourned until the next meeting.

National Society for the Exemption of Machinery from Rating.—By the aid of Mr. Winterbotham, M.P., the Bill for the exemption of machinery from rating has been ordered for second reading on April 16th next. In order to secure the passing of the Bill it is of the utmost importance that every effort should at once be made to obtain the votes of Members of Parliament.

Lecture.—Mr. George Offer will this evening deliver a lecture at St. James's Hall, Piccadilly, in connection with the Balloon Society of Great Britain, on "The Action of Local Authorities and the Board of Trade in connection with the Supply of Electricity." Tickets may be obtained at the offices of the Society, 26, Budge-row, or from Mr. George Offer, 4, Great Winchester-street.

Electric Traction in Vienna.—The Anglo-Bank, which took up 10,000 Preference shares in the Neue Wiener Tramway Gesellschaft have made an offer to the Board of that company to introduce electric traction on some of their lines. If their proposal is accepted the work will be carried out by the Allgemeine Electricitäts Gesellschaft, and the cars run at a fixed price per car kilometre.

Commissioners of Sewers.—Among the petitions presented for signature to the Commissioners of Sewers by the Finance and Improvement Committee at their last meeting was one against the Central London Railway Bill, one against the London Subways and Overhead Wires Bill, and one against the City of London Electric Lighting Bill. The petitions were read to the Court with closed doors.

Incandescent Lamp Signalling.—At the beginning of the present month the American squadron, while lying in Toulon roads, engaged in some striking signalling experiments with incandescent lamps placed on the yards. The experiments were completely successful, the signals from the flagship "Chicago" being easily and quickly interpreted and responded to by the three other ships of the squadron.

Cologne.—From the *Electrotechnisches Echo* we learn that at the meeting of the Town Council on January 25th, Dr. Hegener, of the Municipal Gas and Waterworks, reported on the eight lighting schemes submitted and declared in favour of alternating currents. The proposed station will be in the centre of the town, and will have a capacity of 5,000 incandescent lamps. A credit for 1,850,000 marks was ultimately granted.

Bridlington Quay.—A public meeting of the ratepayers was held on Friday evening last for the purpose of considering the position of affairs with regard to public lighting. Dr. Redman moved "that in the opinion of this meeting the immediate adoption of electricity for public lighting purposes would be a very great improvement, and of great advantage to the ratepayers at large." The resolution was declared carried amidst loud applause.

Country House Lighting.—Mr. W. R. Cookson is having the electric light fitted to Binfield Park, Bracknell. There will be in all over 200 lights, and current will be supplied by a "Parsons" dynamo and accumulators. The generating plant will be situated at the stables and connected to the house by underground conductors, insulated on the "Brooks" oil system. Mr. A. A. Campbell Swinton has been entrusted with the contract for the installation.

An Alternate-Current Electric Clock.—The Helios Company of Frankfort-on-Maine have recently exhibited an alternating-current clock. From measurements taken by the *Electrotechnische Zeitschrift*, the clock takes about ·06 amperes and 34 volts, which, assuming even that there is no self-induction, is only two watts. A number of such clocks would drive synchronously off quite a small motor, and would, of course, keep absolutely together.

Heilbronn.—The Cement Company at Lauffen-on-the-Neckar, which possesses superfluous water power to the extent of 800 horse-power, has obtained permission to lay down a cable for the distribution of light and power in the town of Heilbronn. It is anticipated that 700 horse-power will be available for distribution. The public lighting at present consists of 480 lamps and costs 18,360 marks per annum, and the Town Council have agreed to replace the 480 gas lamps by 120 arcs.

The Liverpool Overhead Railway.—Rapid progress is being made with this railway. At present the work is being pushed forward from the north end of the city, and it is intended to work from the south or Garston end as well, without delay. The contractor hopes to have the whole line completed by July, 1891. No decision as to the system to be adopted will be come to until the last possible moment, in order that the latest developments and improvements in electricity may be taken advantage of.

Magnetic Storms.—In a recent note in the *Comptes Rendus*, M. Zenger remarks:—"I have compared the days of magnetic storms and of aurora borealis with the days of the solar period of 12·6 days, and with the days of the periodic passages of meteoric swarms. The almost absolute coincidence of the dates leads to the conclusion that the electric phenomena produced by the solar influence and by the direct electric discharge between the meteoric swarms and the upper regions of the earth's atmosphere are the cosmic causes which produce both magnetic storms and the aurora."

Extension of the Telegraph Money Order System.—On and after the 1st of March next the Post Office will extend this system, so that money may be transmitted by Telegraph Money Order between all head and branch offices in the United Kingdom at which Telegraph and Money Order business is transacted. In addition to the minimum commission of 4d., a charge will be made at the ordinary Inland rate for the

Digitized by Google

official telegram authorising payment at the Office of Payment and for the repetition thereof, the minimum being 9d.

A Correction.—Physical Society.—In the table of numbers inserted in our report of the discussion of the Paper on "Galvanometers," and published on page 370 of our last issue, the number 4,000 in column D should be 40,000, and in column V the last two numbers should be 125 instead of 250. This mistake also affects the numbers given in the last two columns. Lower down, after the words "Messrs. Elliott's usual practice," the words "many years ago" should have been added. The galvanometer here referred to was No. 1, not No. 3 as stated.

Killarney.—An interesting illustration of the utilisation of natural forces for electric lighting, says the *Freeman's Journal*, is about to be carried out in the town of Killarney. The current for lighting the town is to be generated by water-power at the Flesk Mills, situated a mile and three-quarters from the town, where there are two large water-wheels, which will give ample power in summer and winter for the purpose. Current for some 2,000 lights will be carried overhead on high poles. It is expected that the hotels and all the principal buildings in the town will take the light.

International Exhibition of Mining and Metallurgy.—An exhibition bearing this title will be held on an extensive scale at the Crystal Palace from July 2nd to September 30th next. The exhibition will comprise various kinds of machinery in motion and at rest; mining and treatment of all kinds of metals; electricity in its application to mining and metallurgy, electrical haulage, the electric lighting of mines, electric transmission of power, electrical extraction, processes, telpherage, &c. Further information may be obtained at the offices, 18, Finch-lane, E.C., and applications for space must be forwarded not later than March 15th.

Electrical Competitions.—At its annual meeting in December the Société Industrielle d'Amiens decided to offer the following medals for competitions during 1890:—A gold medal will be given to the best shop or factory electric light installation which has been in operation for at least one year. The installation must be cheaper than gas; gas made on the premises for a 300 or 500 light installation being taken as a standard of comparison. Another gold medal will be awarded to some useful chemical application of electricity within the Amiens district. Finally, a gold medal will be awarded to any meritorious physical memoir.

Budapest.—It is intended to light the whole town by electricity, and the Mayor has asked the gasworks for an estimate. The gasworks offered to reduce the price of gas, and estimated the cost of electricity at 1·35d. per 100 watt-hour, equivalent to about £10 per annum for a 14 candle-power incandescent lamp, the cost of a 14 candle-power gas lamp being £4. In spite of this enormous difference, the town is negotiating for the introduction of the electric light, and will give the gas company till December (when their contract expires) to erect a central station. If this is not done the contract will be put into other hands, as it has been definitely decided to adopt the electric light.

Royal Meteorological Society.—At the last meeting of this Society Mr. E. S. Bruce read a note on "An Optical Feature of the Lightning Flash." It has been stated, he said, in the report of the Thunderstorm Committee of the Royal Meteorological Society that there is not the slightest evidence in the photographs of lightning flashes of the angular zigzag or forked forms commonly seen in pictures. The author, however, believes that this is an optical reality, as the clouds on which the projection of the flash is cast are often of the cumulus type, which afford an angular surface. In support of this theory he exhibited some lantern slides of lightning playing over clouds.

St. James's Vestry.—At the last meeting of this vestry in was agreed to petition against the Central London Railway Bill unless the promoters agreed to the insertion of a clause requiring the company to pay to the London County Council a substantial sum for improvements in consideration of their being allowed to construct the railway under the public thoroughfares. The Sanitary and Parliamentary Bills Committee submitted a report recommending the vestry to petition against the London Subways and Overhead Wires Bill of the London County Council, with a view to the insertion of clauses for the removal of overhead wires within some period to be specified by the Bill. This was carried.

The Puluj Telethermometer.—This telethermometer, which is due to Dr. J. Puluj, of Prague, consists of a carbon and iron spiral placed within a glass tube filled with hydrogen. The carbon and the iron form part of a Wheatstone bridge. Any variation of temperature causes their resistance to alter in opposite ways and thus upset the balance. The amount of this variation is determined by the amount of adjustment required to restore the balance. Variations of temperature of only ·1°C. taking place a kilometre distant can be easily detected by the instrument. Dr. Puluj, in a paper read before the Vienna Scientific Society, gives in detail the method of constructing a scale for the instrument graduated in degrees.

Carrara.—By July next M. Garré, of Carrara, hopes to be in a position to undertake the private and public lighting of the town, as well as the electric distribution of power. At the present moment two 120 horse-power turbines are in course of erection at a waterfall about a kilometre from the town, where a supply is available equal to 27 gallons per minute at a head of 260ft. M. Garré is negotiating with the authorities to light the town by means of 350 16 candle-power incandescents and 25 arcs, at 20 per cent. less than the gas company, and intimates his willingness to supply private customers at the rate of 35fr. per 16 candle-power lamp per annum. It is moreover estimated that 80 kilowatts will be available for power purposes.

The McLaughlin Storage Battery.—Several long trips have recently been made over the Philadelphia People's Line by a car equipped with 92 cells of the McLaughlin storage battery, 46 cells on each side of the car, and two 15 horse-power Sprague motors. With but one exception every trip of this car was satisfactory. The 92 cells were not all used at the same time while the car was in action; only half the number being operated for two hours at a time. The McLaughlin battery cell is 6in. square at the base, and 7in. high, and is composed of silica and sulphur. The plates consist of an alloy of tin and lead. The plate will, it is said, withstand a heavy rate of charge and discharge, and when formation is complete the metallic part of the plate becomes a part of and just as porous as the active material itself.

Berlin.—The following table shows the development of the Berlin Central Station:—

Station.	Effective Horse-Power.						
	1884	1885	1886	1887	1888	1889	When completed.
Friederickstrasse ...	300	300	300	300	300	300	300
Markgrafenstrasse ...	...	1,000	1,000	1,000	2,400	2,400	3,100
Mauerstrasse	...	...	500	1,250	1,250	2,950	4,950
Spandauerstrasse ...	...	...	...	...	...	2,000	4,000
Schiffbauerdamm ...	...	...	...	...	...	1,000	6,000
Total	300	1,300	1,800	2,550	3,950	8,650	18,350
16 c.p. lamps, or equivalent	2,500	4,600	13,229	24,660	34,750	...	...
Kilometres of cable...	..	8	10	15	25	75	...

Edinburgh Exhibition.—A meeting of the London Committee of the Edinburgh Exhibition was held on Monday at the Mansion House. The chairman, Sir George Hayter Chubb, stated that he had recently visited Edinburgh in order to obtain information as to the progress of the Exhibition. The site was undeniably a good one. The space had been applied for twice over, and nearly 100 of the chief electrical firms would exhibit. Several sections would be reserved for foreign countries, some of whom were exhibiting officially. The guarantee fund amounted to £25,410, and though there was every reason to suppose that the Exhibition, like those held in Edinburgh and Glasgow of recent years, would result in a surplus, yet it was desirable that the guarantee fund should amount to £40,000. Various guarantees were handed in, and the committee separated.

Digitized by Google

London County Council.—At the last meeting of the Council the Highways Committee recommended :—"(*a*) That a petition be presented against the City of London Electric Lighting Bill, with a view to obtaining amendments; (*b*) That petitions be presented against the preamble of the Strand Electric Lighting Bill; (*c*) That a petition be presented against the preamble of the St. Martin-in-the-Fields Electric Lighting Bill." The recommendations were adopted. The Highways Committee also reported that they had proceeded upon the resolutions of the Council of December 3rd last as to certain appointments in the engineer's department, and they recommended that Mr. W. Arnot should be appointed, at a salary of £200 a year, to discharge the duties of an inspector under the Electric Lighting Acts, and other duties; that Mr. A. Champion be appointed, at a salary of £3. 3s. a week, to supervise the works; and that Mr. J. Somers be appointed in the engineer's department at a salary of £2 per week. This was approved.

Metropolitan Electric Lighting Areas.—We have received from Mr. Stanford, of Charing Cross, a large coloured map of London, on a scale of 3 inches to the mile, showing the Metropolitan areas allotted under the various Provisional Orders and Licences to supply companies and to the St. Pancras Vestry. The map, which is very similar to that issued as a supplement to *The Electrician* of January 3rd, should prove of great use to all concerned in the electric lighting of the metropolis. Its value would, we think, however, be considerably enhanced if the sites of the central stations of the different companies were prominently marked. The parish of Fulham is, we notice, marked as having been allotted under the Fulham District Order, which was, if we remember rightly, obtained in 1884 by the West Middlesex Electric Lighting Company, whose powers have now lapsed. We have also received from the Kensington and Knightsbridge Electric Lighting Company a map showing the houses in their district now fronting the Company's mains. The Company appear, from this map, to have practically covered the district.

Electrical Installation Rules.—We have received a copy of some rules for electric light installations, compiled and adopted by the Victorian Institute of Engineers and the Fire Underwriters' Association of Victoria. These rules have for the most part been taken without acknowledgment and with remarkable impartiality from those issued by the Institution of Electrical Engineers and by the Phœnix Fire Office. The maximum current which any conductor may carry is fixed by the formula $C = \sqrt{\frac{D}{R}}$; where R represents the resistance of 600ft. of the conductor at 120°F., and D is its diameter in mils. This formula results for small conductors in current density greater than the Board of Trade limit of 1,000 amperes per square inch, while for large conductors the current densities are considerably less. Acid, neutralised before being used, is allowed as a soldering flux. With a view, perhaps, of ensuring good insulation, both the Institution rule and Mr. Heaphy's (with some modifications) have been adopted. A table, giving the safe currents for stranded conductors, calculated from the formula mentioned above, is printed at the end of the rules.

A Second New Zealand Cable.—Our readers will probably remember that in consequence of the interruption for some twelve days last year of telegraphic communication between Australia and New Zealand, the Eastern Extension Telegraph Company decided to lose no time in duplicating their Sydney-Nelson cable, so as to prevent as far as possible further inconvenience to the telegraphing public. The manufacture of the duplicate cable is now completed, and it has been coiled on board the Telegraph Construction and Maintenance Company's s.s. "Scotia," which vessel left yesterday, 20th inst., for Sydney to lay the same. The new line is being put down solely to strengthen the service, the existing cable being fully equal to present traffic requirements. It may also be interesting to learn that the Telegraph Construction and Maintenance Company are manufacturing for the Eastern Extension Company 650 miles of cable for the partial renewal of their Madras-Penang section between Penang and a point west of the Nicobar Islands, where most of the interruptions to this cable have hitherto occurred. The carrying capacity of the new cable will be considerably greater than that of the existing line, and it is expected that this renewal will be carried out during the next few months.

The Overhead Wires at Glasgow.—At the meeting of the Town Council on Monday, the minutes of the Special Committee on overhead electric light cables and wires stated that at a meeting of the Committee on February 7th the clerk submitted correspondence with the Board of Trade and with Messrs. Muir, Mavor, and Coulson (Limited) in regard to overhead electric wires in the city. On behalf of the Board of Trade, Major Cardew, R.E., electrical adviser of the Department, had inspected the installation belonging to Messrs. Muir, Mavor, and Coulson (Limited). His report contained the following :—"This is one of the best installations I have yet seen. The insulated wire used is well up to the standard of our regulations, which have been generally complied with, except in a few cases." Mr. Gray, in moving the approval of the minute, said that although the city architect, Firemaster Paterson, and Mr. Cook, the electrical expert of the Corporation, did not quite agree with Major Cardew's report as to the danger arising from the wires, the Committee were of opinion that they had discharged their duty by calling attention to the matter. He thought, however, it might be better that the Committee should be continued, in order that such questions might be considered. The minute was adopted and the Committee was continued.

Telephone Promotion.—Mr. D. Sinclair, who has been for the last seven years or so engineer to the National Telephone Company in the Glasgow district and over the West of Scotland generally, has been promoted to the Metropolitan district of the same company. He will have entire charge of the four divisions embraced in the Metropolitan district. Prior to joining the telephone service in Glasgow, Mr. Sinclair was for some three or four years in the telegraph service of Japan, and previously he was a telegraph engineer in the employment of the North British Railway Company. As a skilled electrician he has taken high rank. During the last few years Mr. Sinclair read three valuable Papers on telephone matters before the Philosophical Society of Glasgow, and he latterly served on the Council of that Society. Before leaving for London he was presented with a handsome gold watch by the Glasgow staff of the National Telephone Company, as a token of the esteem with which they regarded him, and he was subsequently entertained to dinner by the male members of the staff. Mr. D. Johnstone Smith, C.A., local secretary to the Telephone Company, presided at both farewell meetings. Mr. Sinclair has left behind him many personal and professional friends in Glasgow and throughout the West of Scotland.

The Lighting of the City.—At the last meeting of the Commissioners of Sewers the Streets Committee brought up a report relative to the proposed contract with the Brush Electrical Engineering Company. The company proposes, among other things :—1. That the option of renewing the contract for public lighting after the first 21 years for successive periods of seven years shall be mutual. 2. That the power of the Commission to purchase at the end of 21 years, or at each succeeding seven years, be limited to public lighting only. 3. That the receipts and expenditure in respect of the contract be debited with 5 per cent. interest on the capital and a reasonable sum per annum for depreciation prior to arriving at the cumulative dividend of 10 per cent., and the application of the sliding scale as regards charges and profits. They also think the contract must be conditional on their obtaining a Provisional Order giving them the necessary Parliamentary powers over the district in question, and on their being able to obtain on reasonable terms all necessary way leaves and powers to enable them to lay their mains outside the district to the points at which the main conductors may enter the district, and they suggest that the contract be executed, with a supplemental contract of the same date, making it conditional, as above stated, and providing that the required deposit of £1,000 be returned to them in case these powers cannot be obtained. The Committee recommended the Court to resist Nos. 2 and 3, and to agree to the rest. The report was adopted.

Digitized by Google

MAGNETISM IN IRON AND OTHER METALS.*—VI.

BY PROF. J. A. EWING, F.R.S.

(*Continued from page 342.*)

§ 37.—**Methods of Measuring Magnetic Quality.**—From what has been said about the influence which the ends of magnetised bodies exercise in reacting on the magnetising field, and in exerting a self-demagnetising force when the external force is withdrawn, it will be clear that when we attempt to measure the permeability, or the susceptibility, or the retentiveness of a magnetic metal, we must either arrange the conditions of the experiment in such a way that the influence of the ends may be calculated and allowed for, or else choose pieces which are actually or practically *endless*.

We may use long ellipsoids (short ones will not do, for the reason already explained—that in them the magnetisation depends too much on the form and too little on the quality of the piece), and, having observed I, calculate the true magnetic force within the metal by subtracting N I from the externally applied force H'.

Again, if the piece tested is a very long cylindrical rod or wire, the influence of the ends may be approximately allowed for by treating the piece as an ellipsoid. And by making the length great enough (400 times the diameter or so if the rod is straight) we may reduce the influence of the ends so much that it may generally be neglected. In a rod long enough to be practically endless, the magnetic force within the metal is sensibly the same as the force in the field when the rod is withdrawn from it.

The condition of endlessness can be completely secured by giving the piece to be magnetised the form of a ring. If we take a ring of uniform section, and wind the magnetising coil uniformly all round it, we secure a magnetic field which is uniform throughout the length of the ring, and nearly uniform throughout each cross-section. The magnetic force operative on the metal is quite independent of the magnetism of the piece itself. The ring has no poles; it produces no reaction on the magnetising field; and when the external force is withdrawn it exerts no demagnetising force upon itself.

Ellipsoids, long rods, and rings have all been used in testing the permeability and other magnetic qualities of iron. Recent experiments have, as a rule, been made either with rings (or pieces equivalent to rings), or with very long cylindrical rods. From some points of view, long ellipsoids would be the most satisfactory of all forms of specimen, but the difficulty of shaping them correctly is a serious obstacle to their use.

§ 38. **Classification of Methods: Magnetometric and Ballistic.**—The magnetisation produced in a specimen by applying magnetic force, or, more generally, the change of magnetism produced by any change in the force, is usually measured in one or other of two ways.

In one—the magnetometric method—the magnetism of the piece is measured by observing the deflection of a magnetic needle suspended near it, called a magnetometer. This method is applicable when we deal with ellipsoids and rods, but obviously cannot be used with rings, since a uniformly magnetised ring exerts no magnetic force in the neighbouring space.

In the other method, any change in the magnetic induction within the specimen is determined by measuring the transient current which is induced in a surrounding coil when the change of induction takes place. The coil acts like the secondary wire of an induction coil or transformer. When any change takes place in the number of lines of induction surrounded by the coil, a transient current is produced, the whole quantity of which (that is to say, its time integral) is proportional to the change. This transient current is measured by passing it through a "ballistic" galvanometer, which is a galvanometer with a needle that swings slowly enough to allow practically the whole of the transient current to pass before the needle has stirred to any sensible extent from its position of rest. This "ballistic" method is applicable to rings as well as to rods of any form, and is in fact the only method by which we may examine the magnetic quality of a ring. When applied to rings it serves to measure sudden changes of magnetism only, such as may be caused by making, breaking, reversing, or suddenly increasing or reducing the current in the magnetising coil. When applied to rods the ballistic method may be modified, so that it will measure the actual magnetic state of the piece, and not sudden changes merely. This is done by winding the secondary coil so that it may be suddenly slipped off the magnetised piece, and removed far enough from it to be out of the reach of magnetic influence, remaining, however, all the while in circuit with the ballistic galvanometer. Slipping off the coil gives a transient current which corresponds to the sudden removal of all the lines of induction.

We shall now describe the two methods in some detail, and give examples of their application.

§ 39. **Magnetometric Method.**—In this method the rod or other piece whose magnetisation is to be measured is fixed near

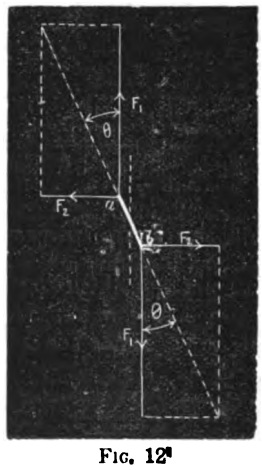


FIG. 12.

the magnetometer, the needle of which is already directed by some known magnetic force. Generally, the needle hangs horizontally under the control of the earth's magnetism alone, so that the directing force is the horizontal component of the earth's magnetic field. The magnetised piece is fixed in such a position that the magnetic force which it produces at the magnetometer, or what we may call the deflecting force, acts at right angles to the directing force. The tangent of the angle of deflection then measures the proportion of the deflecting to the directing force. Thus, in Fig. 12, if the magnetised

FIG. 13.

body is placed so that it produces a magnetic force F_2 at the magnetometer needle $a\,b$, and the directing force is F_1, the needle, which originally pointed in the direction of F_1, is deflected through an angle θ such that

$$F_2 = F_1 \tan \theta.$$

Knowing F_1 and observing θ, we determine F_2, and from that, knowing the position and dimensions of the magnetised piece, we calculate its intensity of magnetisation.

Suppose, for instance, that the magnetic bar is an ellipsoid of revolution (with polar axis $2c$ and equatorial axes $2a$) placed in

* All rights are reserved.

Digitized by Google

the position shown by the line C C′ in Fig. 13. The bar lies horizontally, level with the magnetometer needle O, which is opposite the middle of the bar and points to it when in the undeflected position. In its action on a distant point the ellipsoidal bar is, as we have seen in § 27, equivalent to a positive pole of strength $\pi a^2 I$ at Q and an equal negative pole at Q′, the distance Q Q′ being $\frac{4}{3}c$. The deflecting force F_2 which the bar produces at the magnetometer is the resultant of the equal forces

$$\frac{\pi a^2 I}{\overline{O Q}^2} \text{ and } -\frac{\pi a^2 I}{\overline{O Q'}^2}.$$

Its direction is parallel to the bar, and, as the diagram shows,

$$F_2 : \frac{\pi a^2 I}{\overline{O Q}^2} :: \overline{Q Q'} : \overline{O Q},$$

or

$$F_2 = \frac{\pi a^2 I \overline{Q Q'}}{\overline{O Q}^3} = \frac{4 \pi a^2 c I}{3 \overline{O Q}^3}.$$

And, since $F_2 = F_1 \tan \theta$, we may put this result in the following form, suitable for finding the intensity of the bar's magnetisation :—

$$I = \frac{3 \overline{O Q}^3 F_1 \tan \theta}{4 \pi a^2 c}.$$

(To be continued.)

UNDERGROUND MAINS.

BY G. L. ADDENBROOKE.

VI.

(Concluded from page 369.)

THE CALLENDER BITUMEN COMPANY'S SYSTEMS.

In a quiet and steady manner this company, whose experience of underground mains is second to none, have been taking a large share in the underground-main laying which has lately been done. They have worked out two or three complete systems to suit different purposes, besides the manufacture of their bitumen-covered cables.

From the commencement of electric lighting the Callender Company has identified itself with underground work, and they had considerable experience first of all in laying mains for large private installations. The method of construction they have chiefly used for this work consists, in the first place, of a ¾in. wooden trough, having only a bottom and two sides; across the bottom of this trough wooden bridge-pieces are laid every two feet or so, having two or three notches as required to take the cables. These bridge-pieces merely serve to keep the cables from touching the bottom of the trough. After the cables have been laid, the whole trough is filled with bitumen to the top, thus embedding the cables in a thick, impervious coating of highly insulating material. After a time the bitumen sets, so that it is not a matter of the first importance whether the wood remains sound or not, as the bitumen will still retain its form. It is found also that it is sufficiently elastic to follow any slight subsidence of the ground without cracking. The company state that they have many private installations in which this method of laying the mains has been followed, and which have been running since 1883 without giving any trouble.

For central station work the company uses generally a more elaborate system, but of the same type as the above; three sided iron troughs—that is, with a bottom and two sides—being substituted for the wooden ones, as shown in Fig. 19. These iron troughs are made in 6ft. lengths, and have overlapping joint, and succeeding lengths are held together by a screw and bolt just to keep them in their places; there is considerable play in these joints, so that the troughs can be made to follow curves, though a curved pattern is used when the bends are very sharp. These troughs, when laid, are fitted with the wooden bridge-pieces already described, and the cables laid each in its notch; the trough is then filled with bitumen, and a thin layer of concrete put over the top, or the top may have an iron covering. The troughs are made to contain two, three, or four cables, as required, and two layers of cables can if necessary be put in one above the other. As far as possible the company avoid joints in continuous lengths of cable, but where they are necessary the inner layers are scarf-jointed, and the outside married together, and the joint is run solid with solder. Insulating material is then lapped round the joint to the full thickness of the insulation of the cable. This lapping material is only half vulcanised when it is put on; a lamp is brought underneath afterwards, and the whole warmed so as to complete the vulcanisation and make all the lapping solid.

The principle on which the company advise laying mains is as far as possible to complete the service mains in each locality to their full probable ultimate capacity at once, their experience being that, taking into consideration the cost of getting up the streets and making good again, besides troughs, &c., the extra amount of cable required to complete the service mains does not form a very large additional expense as compared with the others, and when once the work is carried out and completed there is no further outlay. It is not proposed that the full number of feeders should be put in at once; these can be added afterwards as required, and as the lights get taken up.

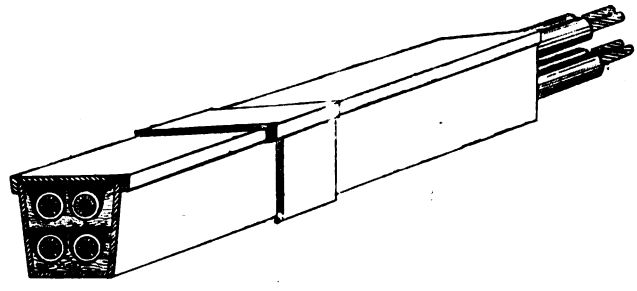


FIG. 19.—Callender Company's system. Iron trough for cables filled with bitumen.

The mains for the Liverpool Electric Lighting Company, whose career has been so successful, have been laid by the Callender Company on this principle, and a special class of junction-boxes has been devised to work with it. These junction-boxes are of cast iron and nearly square, and the cables are brought in at the two ends. The opposite ends of each of these cables are then united by bronze bridge-pieces, and from these bridge-pieces the connections are made for local customers. The system which has been pursued at Liverpool is to place one of these junction-boxes opposite the centre of each block of buildings, the various connections for the houses in that section of street radiating from this box, and being formed by laying lead-covered cables in wooden troughs filled with bitumen. One junction-box thus, as a rule, serves several houses, though in some cases when a large establishment takes a great number of lights a special junction-box is used for this one place alone. The cables connecting to customers come in at the side of the box, and are brought up to bronze connections, from whence they can be connected across to the mains, and cut-outs are usually inserted at the junctions. The box itself is partially filled with bitumen, so as to cover over all the cables and the joints where they enter the box, and this bitumen is made continuous with that in the troughs outside. Great pains are taken with the lids of these boxes, which, by means of a bolt through the middle, and an india-rubber packing all round the edge, are kept absolutely watertight. A separate lid of the G. P. O. type fits over the box-lid.

For heavy feeders the Callender Company have been laying at Liverpool large cables of 1,000 square millimetres section, thoroughly insulated with bitumen, and then covered with a lead tube of ample thickness. Two of these are laid in a deep narrow trough, one above the other, and the whole filled with bitumen. With such precautions there seems no reason why such work should not last indefinitely.

Digitized by Google

At Bath the "solid" system is being used for high-tension alternating-current and arc-lighting wires.

Besides the systems already described, the Callender Company, as is well known, also make conduits on the Callender-Webber system. This is a drawing-in-and-out system, with a separate hole for each cable. Messrs. Callender state that their experience of cables drawn into pipes several together is that, although it may be possible to add single cables when required, yet that the cables will overlay each other and get interlaced

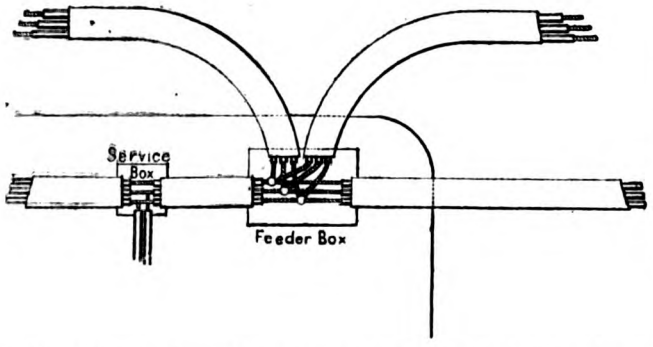


FIG. 20.—Callender Company's system. General method of running the mains and feeders (plan).

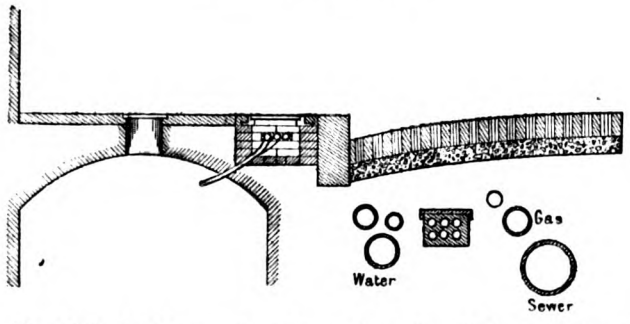


FIG. 21.—Callender Company's system. General method of running the mains and feeders (section).

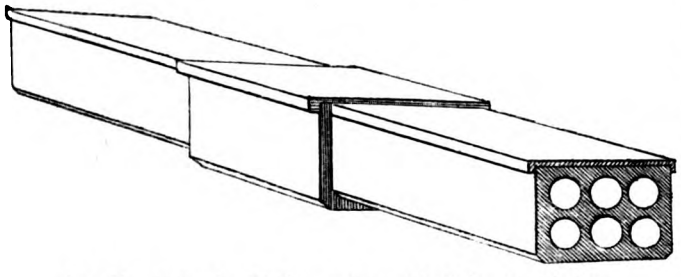


FIG. 22.—Callender-Webber system. Conduit, general view.

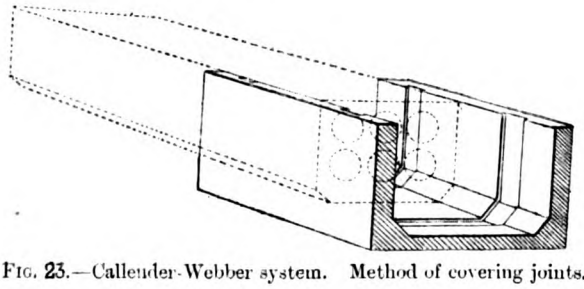


FIG. 23.—Callender-Webber system. Method of covering joints.

in such a way that it is very difficult to withdraw any one of them afterwards should it need repair. Figs. 20 and 21 show in plan and section the general method of running the feeders and mains. The feeders are usually carried under the roadway and the service mains under the footpaths.

There are various ways in which the conduits are formed, according to the purpose for which they are to be used and the size of the cables they will have to carry. In the form which the Chelsea Electric Light Company are using, the cases are laid plain, without further protection, but in the work which has been put down for Messrs. A. and S. Gatti in the Strand, the bitumen conduit is enclosed in a three-sided iron trough, which is used upside down; that is, there is iron above but none below where the conduit rests on the ground. Figs. 22 and 23 show the general form of the conduits, the method of protecting them, and of covering the joints. These bitumen conduits with the holes through them are made to project about a couple of inches at each end beyond their iron case. To join them together, two are brought end to end, and long mandrils of the proper size pushed through the holes into the next block so that they pass through the joints. Hot bitumen is then poured over the joint and the conduit pressed against its neighbour. A short piece of iron troughing of the same shape as the longer pieces containing the conduit is then made hot and slipped over the joint, melting the bitumen to some extent and making everything perfectly solid and water-tight. After the joint has had time to cool sufficiently, the mandrils are withdrawn, and the addition of the next section proceeded with. The Callender Company state that they are able to draw long lengths of cable into these conduits and to withdraw them if necessary.

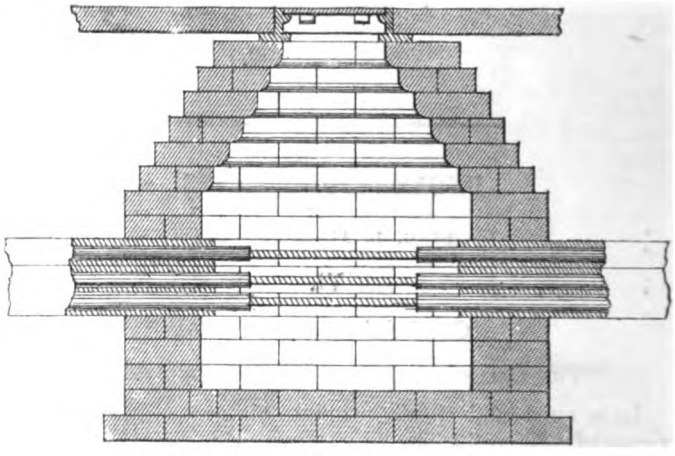


FIG. 24.—Callender-Webber system. Manhole.

Junction-boxes and manholes are used with this system as per sketch (Fig. 24), being arranged to suit the requirements of each special case.

It will be noticed that in joining together the sections in the Callender-Webber system the blocks are simply made continuous, nothing being used at the joints. This is a somewhat important point, as the paper tubes used to keep the holes free at the joints, in work somewhat on the same lines in America, have proved a considerable source of subsequent trouble. It has often been objected to this class of conduit that it may crack, but in practice it is not found to do so: the bitumen, being of a slightly viscous nature, has always a certain amount of give in it.

CONCLUSION.

The description of the leading systems of laying underground mains at present in use is now concluded, and a tabulated list is appended giving the methods and systems employed in many of the best-known installations, which in this form it is thought may prove useful, and to which the editor will be glad to receive any additions.

LIST OF CENTRAL ELECTRIC LIGHT STATIONS SHOWING CHARACTER OF UNDERGROUND DISTRIBUTING SYSTEM.

Town.	Company and System.	Underground Mains.
London	London Electric Supply Corporation; alternating, 2,400 volts.	India rubber cables in iron pipes. Siemens' concentric cable. Ferranti patent main.
"	Metropolitan Electric Supply Company; alternating, 1,000 volts.	Chiefly india rubber cables in iron pipes.
"	House-to-House Electric Light Supply Company; alternating, 2,000 volts.	India rubber cables in iron pipes.

Digitized by Google

Town.	Company and System.	Underground Mains.
London	Kensington and Knightsbridge Electric Lighting Company; low tension.	Cement conduits with bare copper rods on glass insulators. Callender cables when no room for this. (Crompton system.)
„	St. James and Pall Mall Electric Light Company; low tension.	Copper strips on china insulators in iron troughs.
„	Chelsea Electricity Supply Company; low tension and battery.	Callender-Webber conduits and Callender cables.
„	Gatti Bros., Strand; low tension.	Callender-Webber system.
„	Westminster Electric Supply Corporation; low tension.	Probably Crompton's system.
Bradford.....	Corporation; low tension.	Siemens' cables.
Leamington...	Midland Electric Light and Power Company; low tension.	Brick conduits and Callender cables.
Bath.....	Bath Electric Light Works; arc and alternate, 2,000 volts.	Callender, solid conduits.
Eastbourne... Hastings..... Brighton.....	Local Companies; alternating, 1,000 volts and arcs.	India rubber cables, in iron pipes when underground.
Liverpool	Liverpool Electric Supply Company; low tension.	Callender, solid bitumen conduits.
Paris	Municipality. Halles Centrales; alternating, low tension.	Rubber-covered cables on insulators in conduits and sewers.
Berlin	Low tension.	Siemens' armoured cables.
Rome ..... Milan ..... Turin	Alternating, 2,000 volts.	Siemens' armoured concentric cables.
New York ...	Edison Company; low-tension.	Edison Company's system and cables, in separate iron pipes for feeders.
New York ...	Illuminating Company; chiefly arc.	Board of Electrical Control subways, chiefly iron pipes and hard rubber lead-protected cables.
Chicago	Illuminating Company; chiefly arc.	Principally iron pipes with okonite cables in them, partly sewers.

PROBLEMS IN THE PHYSICS OF AN ELECTRIC LAMP.*

BY PROF. J. A. FLEMING, M.A., D.SC., M.R.I.

More than eighty years ago Sir Humphrey Davy provided the terminal wires of his great battery of 2,000 pairs of plates with rods of carbon, and, bringing their extremities in contact, obtained for the first time a brilliant display of the electric arc.† The years that have fled away since that time have seen all the marvellous developments of electro-magnetic engineering, have placed in our possession the electric glow-lamp, and brought the art of electrical illumination to a condition in which it progresses each year with giant strides. In addition to the importance attaching to their ever-increasing industrial use, there are many questions of purely scientific interest which present themselves to our minds when we proceed to examine the actions that take place when a carbon conductor is rendered incandescent in a high vacuum, or when an electric arc is formed between two carbon poles. It is to a very few of these physical problems that I desire to direct your attention to-night, but more especially to one which is particularly interesting from the bearing which it has on the general nature of electric discharge.

We know as a very familiar fact that if we attempt to raise the temperature of a carbon conductor enclosed in a vacuum beyond a certain limit, not far removed from the melting point of platinum, the carbon begins to volatilise with great rapidity. If an electric glow-lamp has passed through its carbon more than a certain strength of current, the glass bulb speedily becomes darkened by a deposit of this volatilised carbon condensed upon it; and experience shows us that we cannot raise the temperature of that carbon beyond a definite point without causing this waste of the conductor to become very rapid. In the highly rarefied atmosphere within the bulb of a glow-lamp, the carbon, when at its normal incandescence, must be considered to be projecting off molecules of carbon in all directions, partly in virtue of purely thermal actions, but probably also in consequence of certain electrical effects to be presently discussed. This scattering of the material of the carbon conductor takes place with disadvantageous rapidity from an industrial point of view at and beyond a certain temperature,* but it exists as well at much lower temperatures than that which is found to determine the practical limit of durability. A curious appearance is found in many incandescent lamps which have been "over-run," which shows us that this projection of carbon molecules from the hot conductor is not, perhaps, best described by calling it a vaporisation of its substance, but that the surface molecules are shot off in straight lines, and that they reach the glass envelope without being hindered to any great extent by the molecules of the residual air.

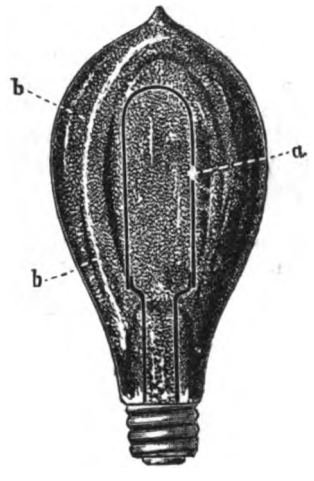


FIG. 1.—Glow lamp having the glass bulb blackened by deposit of carbon. Molecular scattering having taken place at *a*, and shadow or line of no deposit produced at *b*.

If an electric current is passed through an otherwise uniform carbon conductor, which possesses at any one place a specific resistance higher than that of the remaining portion, the current, in accordance with a well-known law, there develops a higher temperature, and the molecular scattering at that spot may in consequence be greatly exaggerated. It may be that the detrition of the conductor at that locality will be so great as to cut it through after a very short time. When the carbon has the form of a simple horseshoe loop, and when this molecular scattering takes place from some point in the middle of one branch, the molecular projection makes itself evident by producing a "molecular shadow" of the other leg upon the interior of the glass. I will project upon the screen an image of the carbon horseshoe loop taken from an old glow-lamp, and you will be able to see that the filament has been cut through at one place. At that position some minute congenital defect caused the carbon to have a higher resistance, the temperature at that point when it was in use became excessive, and an intensified molecular scattering took place from that locality. On examining the glass bulb from which it was taken, we find that the glass has been everywhere darkened by a deposit of the scattered carbon except along one narrow line, (*see* Fig. 1), and that line is in the plane of the carbon loop and on the side opposite to the point of rupture of the filament.

* A discourse delivered at the Royal Institution on Friday evening, February 14, 1890.

† Sir Humphrey Davy laid a request before the managers of the Royal Institution on July 11, 1808, that they would set on foot a subscription for the purchase of a large galvanic battery. The result of this suggestion was that a galvanic battery of 2,000 pairs of copper and zinc plates were set up in the Royal Institution, and one of the earliest experiments performed with it was the production of the electric arc between carbon poles, on a large scale. It is probable, however, that Davy had produced the light on a small scale some six years before, and, according to Quetelet Curtet, observed the arc between carbon points in 1802. *See* Dr. Paris' "Life of Sir H. Davy."

* When the rate of expenditure of energy in the carbon conductor is raised until it reaches a value of about 500 watts, or 360 foot-pounds per second per square inch of radiative surface, a limit of useful temperature has been reached for economical working, under the usual present conditions of steam-engine-driven dynamos and modern glow-lamps.

Digitized by Google

I might illustrate to you by a very simple experiment the way in which that "shadow" has been formed. Here is a ∩-shaped rod: this shall represent the carbon conductor in the lamp; this sheet of cardboard placed behind it, the side of the glass receiver. I have affixed a little spray-producer to one side of the loop, and from that point blow out a spray of inky water. Consider the ink spray to represent the carbon atoms shot off from the overheated spot. We see that the cardboard is bespattered on all points except along one line where it is sheltered by the opposite side of the loop. We have thus produced a "spray shadow" on the board (Fig. 2). The existence of these molecular shadows in incandescent lamps leads us therefore to recognise that the carbon atoms must be shot off in straight lines, or else obviously no such sharp shadow could thus be formed. This phenomenon confirms in a very beautiful manner the deductions of the Kinetic theory of gases. I may remind you that at the ordinary temperature and pressure the mean free path of a molecule of air is deduced to be about four one-millionths of an inch. This is the average distance which such a gaseous molecule moves over before meeting with a collision against a neighbour which changes the direction of its path. Let the air be rarefied, as in these bulbs, to something like a millionth of the ordinary atmospheric pressure, and the mean free path is increased to several inches. The space within the bulb—though from one point of view densely populated with molecules of residual air—is yet, as a fact, in such a condition of rarefaction that a carbon molecule projected from the conductor can move over a distance of three or four inches on an average without meeting with interference by collision with another molecule, and the facts revealed to us by these shadows show that this must be the case. I have also at hand some Edison lamps in which these "molecular shadows" are finely shown, but in these cases the deposit on the interior of the bulb is not carbon but copper, because the molecular scattering has here taken place by excessive temperature developed at the copper clamps by which the carbon filament is attached to the platinum wires.

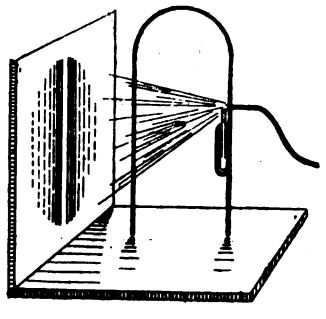


Fig. 2.—"Spray shadow" of a rod thrown on blotting paper screen to illustrate formation of molecular shadow in glow lamps.

The theory, however, is the same. The deposit of copper shows a fine green colour by transmitted light in the thinner portions. One curious lamp also before me had by an accident an aluminium plate volatilised within the bulb. The glass receiver has in consequence been covered with a mirror-like deposit of aluminium, which on the thinner portions shows a fine blue colour by transmitted light, and a silvery lustre by reflected light. This lamp also shows a fine "molecular shadow."

These facts prepare us to accept the view that when a glow-lamp is in operation the highly rarefied residual air in the interior of the bulb is being traversed in all directions by multitudinous carbon atoms projected off from the incandescent carbon conductor. I now wish to pass in review before you some facts which indicate that these carbon atoms carry with them electric charges, and that they are charged, if at all, with *negative electricity*. I may preface all by saying that much of what I have to show you will be seen to be closely related to the phenomena studied by Mr. Crookes in his splendid and classical researches on radiant matter. Our starting-point for this purpose is a discovery made by Mr. Edison in 1884, and which received careful examination at the hands of Mr. Preece in the following year,* and by myself more recently. Here is the initial experiment. A glow-lamp having the usual horseshoe-shaped carbon (*see* Fig. 3) has a metal plate held on a platinum wire sealed through the glass bulb. This plate is so fixed that it stands up between the two sides of the carbon arch without touching either of them. We shall illuminate the lamp by a continuous current of electricity, and for brevity's sake speak of

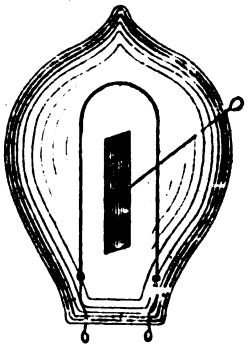


Fig. 3.—Glow lamp having insulated metal. Middle plate M sealed into bulb to exhibit "Edison effect."

that half of the loop of carbon on the side by which the current enters it as the negative leg, and the other half of the loop as the positive leg. The diagram in Fig. 4. shows the posi-

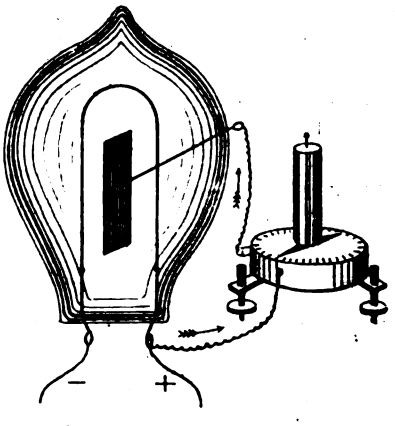


Fig. 4.—Sensitive galvanometer connected between the middle plate and positive electrode of a glow lamp, showing current flowing through it when the lamp is in action ("Edison effect").

tion of the plate with respect to the carbon loop. There is a distance of half-an-inch, or in some cases many inches, between either leg of the carbon and this middle plate. Setting the

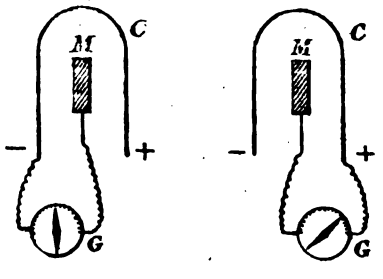


Fig. 5.—Mode of connection of galvanometer G to middle plate M and carbon horse-shoe shaped conductor C in the experiment of the "Edison effect."

lamp in action, I connect a sensitive galvanometer between the middle plate and the *negative terminal* of the lamp, and you see that there is no current passing through the instrument. If, however, I connect the terminals of my galvanometer to the middle plate and to the *positive electrode* of the lamp, we find a current of some milliamperes in passing through it. The diagrams in Fig. 5 show the mode of connection

* Mr. Preece's interesting Paper on this subject is published in the *Proceedings of the Royal Society* for 1885, p. 219. See also *The Electrician* April 4, 1885, p. 436.

Digitized by Google

of the galvanometer in the two cases. This effect, which is often spoken of as the "Edison effect," clearly indicates that an insulated plate so placed in the vacuum of a lamp in action is brought down to the same potential or electrical state as the negative electrode of the carbon loop. On examining the direction of the current through the galvanometer we find that it is equivalent to a flow of negative electricity taking place through it *from* the middle plate *to* the positive electrode of the lamp. A consideration of this fact shows us that there must be some way by which negative electricity gets across the vacuous space from the negative leg of the carbon to the metal plate, whilst at the same time a negative charge cannot pass from the metal plate across to the positive leg Before I pass away from this initial experiment, I should like to call your

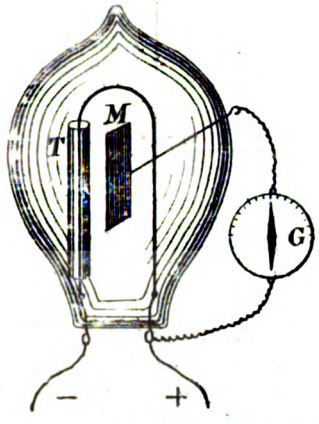


FIG. 6.—Glow lamp having negative leg of carbon enclosed in glass tube *T*, "Edison effect" thereby being annulled or greatly diminished.

attention to a curious effect at the moment when the lamp is extinguished. Connecting the galvanometer as at first, between the middle plate and the negative electrode of the lamp, we notice that though made highly sensitive the galvanometer indicates no current flowing through it whilst the lamp is in action. Switching off the current from the lamp produces, as you see, a violent kick or deflection of the galvanometer, indicating a sudden rush of current through it.

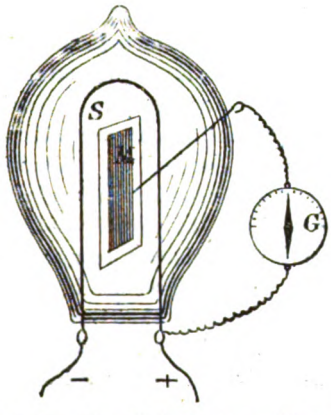


FIG. 7.—Glow lamp having mica shield *S* interposable between middle plate *M* and negative leg of carbon, thereby diminishing the "Edison effect."

In endeavouring to ascertain further facts about this effect one of the experiments which early suggested itself was one directed to determine the relative effects of different portions of the carbon conductor. Here is a lamp (*see* Fig. 6) in which one leg of the carbon horseshoe has been enclosed in a glass tube of the size of a quill, which shuts in one half of the carbon. The bulb contains, as before, an insulated middle plate. If we pass the actuating current through this lamp in such a direction that the covered or sheathed leg is the *positive* leg, we find the effect existing as before. A galvanometer connected between the plate and positive terminal of the lamp yields a strong current, whilst if connected between the negative terminal and the middle plate there is no current at all. Let us, however, reverse the current through the lamp so that the shielded or enclosed leg is now the negative one, and the galvanometer is able to detect no current, whether connected in one way or in the other. We establish, therefore, the conclusion that it is the negative leg of the carbon loop which is the active agent in the production of this "Edison effect," and that if it is enclosed in a tube of either glass or metal, no current is found flowing in a galvanometer connected between the positive terminal of the lamp and this middle collecting plate.

Another experiment which confirms this view is as follows:—This lamp (*see* Fig. 7) has a middle plate, which is provided with a little mica flap or shutter on one side of it. When the lamp is held upright the mica shield falls over and covers one side of the plate, but when it is held in a horizontal position the mica shield falls away from the front of the plate and exposes it. Using this lamp as before we find that when the positive leg of the carbon loop is opposite to the shielded face of the plate, we get the "Edison effect" as before in any position of the lamp. Reversing the lamp current and making that same leg the *negative* one, we find that when the lamp is so held the metal plate is shielded by the interposition of the mica, and the galvanometer current is very much less than when the shield is shaken on one side and the plate exposed fully to the negative leg.

(To be continued.)

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To night) FRIDAY, February 21st.

PHYSICAL SOCIETY.

5 p.m. Papers to be read: (1.) "On a Carbon Deposit in a Blake Telephone Transmitter." By F. B. HAWES. (2.) "The Geometrical Construction of Direct-Reading Scales for Reflecting Instruments." By A. P. TROTTER, B.A. (3.) "A Parallel Motion Suitable for Recording Instruments." By A. P. TROTTER, B.A. (4.) "On Bertrand's Refractometer." By Prof. S. P. THOMPSON.

INSTITUTION OF CIVIL ENGINEERS.

7:30 p.m. Students' Meeting. Paper to be read: "Some Types of American Locomotives and their Construction." By C. N. GOODALL, Stud.Inst.C.E.

ROYAL INSTITUTION.

9 p.m. Lecture, "Magnetic Phenomena." By SHELFORD BIDWELL, F.R.S.

SATURDAY, February 22nd.

ROYAL INSTITUTION.

3 p.m. Lecture: "Electricity and Magnetism." By the Right Hon. Lord RAYLEIGH, F.R.S.

TUESDAY, February 25th.

ROYAL INSTITUTION.

3 p.m. Lecture: "The Post-Darwinian Period." By G. J. ROMANES, F.R.S.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Papers to be further discussed: "The Shanghai Water-Works." By J. W. HART, M.Inst.C.E. "The Tytam Water-Works, Hong Kong." By JAS. ORANGE, Assoc.M.Inst.C.E. "The Construction of the Yokohama Water-Works." By J. H. T. TURNER, Assoc.M.Inst.C.E.

WEDNESDAY, February 26th.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Paper to be read: "The English in Florida." By ATHUR MONTEFIORE.

THURSDAY, February 27th.

SOCIETY OF ARTS

5 p.m. Indian Section. Paper to be read: "The Northern Shan State and the Burma-China Railway." By WILLIAM SHERRIFF.

LONDON INSTITUTION.

6 p.m. Lecture: "The Rise of British Dominion in India." By Sir ALFRED C. LYALL, K.C.B.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary Meeting. Discussion on the following Papers: "The Theory of Armature Reaction in Dynamos and Motors." By JAMES SWINBURNE, M.I.E.E. "Some Points in Dynamo and Motor Design." By W. B. ESSON, M.I.E.E.

Digitized by Google

The Electrician.

Published every Friday. Price Fourpence; Post Free, Fourpence Halfpenny
Editorial, Publishing and Printing Offices:

No. 1, SALISBURY COURT, FLEET STREET, LONDON, E.C.

Telephone No. 2714. Telegrams: "ELECTRICIAN NEWSPAPER, LONDON."

All Communications to be addressed to "THE ELECTRICIAN," *1, Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN."

All letters intended for insertion in "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. Subscribers should receive their copies by the first post on Friday morning.*

"THE ELECTRICIAN" *is on sale at the railway bookstalls throughout the United Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices as above*

SPECIAL NOTICE.

Owing to the increase in the number of pages of "THE ELECTRICIAN," in order to partly cover the increased postage, we have been compelled to revise the rates for Foreign Subscriptions, which are now as follows:—

	3 months.			6 months.			12 months	
For Foreign Parts and Colonies:—	s.	d.		s.	d.		s.	d.
Within Postal Union	6	6	...	12	6	...	24	0
Aden, Borneo, Ceylon, China, India, Japan, Java, Labuan, Mozambique, New Caledonia, Persia, Philippine Islands, Siam, Transvaal, and Zanzibar	7	6	...	14	6	...	28	0
The rates for the United Kingdom remain as follows:—	5	0	...	10	0	...	19	6

TO ADVERTISERS.

"THE ELECTRICIAN" *offers exceptional advantages to Advertisers.* **It has the largest circulation of any English Electrical paper, and circulates all over the World.**

Particulars relating to Advertisements will be promptly forwarded on application to the office.

TRADE ADVERTISEMENTS *intended for the current issue must be handed in not later than First Post on Thursday morning.*

SMALL PREPAID ADVERTISEMENTS *(for Rates see page xv.) are accepted up to 4:30 p.m. on Thursday.*

TECHNICAL PRINTING.

"THE ELECTRICIAN" PRINTING AND PUBLISHING COMPANY (LIMITED) *beg to inform Electricians, Electric Light Engineers, &c., that they make a specialty of Technical Printing, and have a Staff thoroughly acquainted with Electro-Technology. They can, therefore, promise Accuracy and Despatch in the Printing of Electrical Catalogues and Electro-Technical Literature generally.*

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.

Royal 8vo, 5s., postage extra.

Early in each year is issued "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK. *The* DIRECTORY *was established in 1883, and the 1889 Edition consisted of more than 600 pages of printed matter. The names and addresses of all persons engaged in the Electrical Industries may be relied upon as accurate. Useful Tables and Electrical Formulæ, and information specially compiled for this work are given, together with popularly-written Biographical Notices of the leading Electricians, Electrical Engineers, &c., accompanied in many cases by Portraits.*

The issue for 1890, which is still further enlarged and improved (making 850 pages), is NOW READY. Orders should be forwarded at once to the Publishing Offices, Salisbury-court, Fleet-street, London, E.C.

CONTENTS OF THE CURRENT NUMBER.

NOTES 385
Magnetism in Iron and other Metals.—VI. By Prof. J. A. Ewing, F.R.S. Illustrated. Continued 390
Underground Mains.—VI. By G. L. Addenbrooke. Illustrated. Concluded 391
Problems in the Physics of an Electric Lamp. By Prof. J. A. Fleming, M.A., D.Sc., M.R.I. Illustrated 393
Meetings of Scientific Societies. 395
HIGH AND LOW TENSION 396
The Institution of Electrical Engineers—
The Theory of Armature Reactions in Dynamos and Motors. By James Swinburne. Illustrated. Continued 397
American Notes 402
CORRESPONDENCE—
The Economic Ratio of a Traction System.—Louis Bell 403
CORRESPONDENCE—*Continued.*
Prof. Ayrton's Paper "On Galvanometers."—Elliott Bros. 404
Telephones for Domestic Use.—A. A. Campbell Swinton. Illustrated 404
The Fulham Vestry and the Electric Light.—Russell Spokes 404
Parsons and Co.'s Dynamos and Motors. Illustrated 405
Trade Notes and Notices 405
Improved Back Block. Illus... 405
Books Received 405
COMPANIES' MEETINGS, &c.—
The India-Rubber, Gutta-Percha and Telegraph Works Company (Limited) 406
City of London and Southwark Subway Company ... 407
Chelsea Electricity Supply Company (Limited) 407
New Companies Registered ... 409
City Notes, &c. 409
Companies' Share List 410

"THE ELECTRICAL WORLD" OF NEW YORK.

"THE ELECTRICAL WORLD" OF NEW YORK *can be obtained from* "THE ELECTRICIAN" *Office, Salisbury-court, Fleet-street, London, E.C. The Rate of Subscription (payable in advance), is* **£1 1s.** *per annum. Single Copies* **price 6d. each; post free, 8d.**

"THE ELECTROTECHNISCHE-ZEITSCHRIFT" OF BERLIN.

In future the above journal (with which has been incorporated "The Centralblatt für Electrotechnik") will be issued weekly instead of fortnightly, the subscription being **£1. 4s. 6d.** *per annum. Single Copies* **6d.; post free, 7½d.**

"THE ELECTRICIAN" PRINTING AND PUBLISHING COMPANY, Ltd., *are Agents in Great Britain for both the above well-known journals, and particulars as to Advertisements will be supplied on application to "The Publisher," 1, Salisbury Court, Fleet Street, E.C.*

HIGH AND LOW TENSION.

The controversy which was started exactly two years ago, at the Institution of Electrical Engineers, on the relative merits of transformer and accumulator methods of distribution, served a valuable purpose in revealing the various advantages which these rival systems possess, and, by stimulating competition, contributed much to advance electrical industry as a whole. It even caused some engineers to partially adopt the use of the system which they had previously very strongly opposed. It is, however, much to be regretted, in the interests of the electrical profession in general, that this controversy, which has never died out, and which has continually reappeared in some form or other, has lately taken a much less praiseworthy turn. The great energy and enterprise of the advocates of high-tension alternating systems in England and in America has, on the whole, been attended with striking success. The workers of low-tension systems declare, however, that the use of such high pressures is dangerous to life and should be stopped. Articles to this effect have appeared in the English and American press, but, as commercial interests have in many cases formed the chief motive for writing, the conclusions arrived at must be treated *cum grano salis*. The discussion originated with the overhead wire dispute in New York. This has aroused a great deal of interest on both sides of the Atlantic, and an excellent opportunity has thus arisen for calling attention to another matter with which it has little or no connection. The emphatic statement of Mr. EDISON, that "there is no plea which will

Digitized by Google

justify the use of high-tension or alternating currents," which, according to him, are dangerous, unreliable, and unsuitable for use, is too evidently biassed to be worthy of notice were it not for the fact that such statements, made by public men, are likely to bring about restrictive legislation, which there may be nothing to justify, and which would certainly injure electrical interests as a whole. It is to the interest of electrical engineers generally to encourage progress in every direction. The present condition of electrical industry is such, that advance in any one direction is a benefit to the whole profession. Everyone admits that the transmission of power to long distances is only possible by means of the employment of high electric pressures, so that the attempt to restrict the use of such high potentials will not only tend to seriously injure an important branch of electrical engineering, but will also prevent the natural development of another, which in the future will probably be of the greatest importance. The present acrimonious assertion of the defects of each system by the advocates of the other is also likely in many instances to dissuade the public from using either of them, whereas there is plenty of work for both.

Each system possesses many undisputed advantages, some of which we may briefly enumerate. A low-tension continuous-current system is very highly efficient and eminently suitable for thickly populated districts for comparatively short distances around the central station. Excellent motors can be obtained to work in connection with the system, which, moreover, possesses all the advantages of storage, viz., steadiness in action and the avoiding of continuous work, so that the engines can be always driven at full load. When electricity has to be supplied over larger areas the cost of the conductors may be diminished by the use of three-wire or other multiple conductor systems, and by arrangements of feeders. In spite of the extra complication thus introduced, the working is economical and satisfactory. The margin of profit, when gas is as cheap as it is in England, is so small in many cases, however, that the diminution in cost of the conductors obtained by the use of higher tensions is sufficient to make the difference between success and failure. At present this state of things in many cases renders a high-tension system the only remunerative one possible. With high-pressure systems it is possible for the central station to be placed at a distance from the area of supply, in a position where coal and water may be had cheaply, and where its presence will inconvenience none. With alternating currents it is possible to transform efficiently the high-pressure electricity necessarily used for economy, into low-pressure electricity suitable and safe for house-lighting. There is no question that for the lighting of scattered districts it is the only system which can pay, and that where overhead wires are permissible it is exceedingly economical. On the other hand, alternating-current motors are as yet not nearly so efficient as direct-current ones, and the economy effected in conductors is diminished if they have to be placed underground, since in that case the cost of the conductors is only a part of the cost of the circuit. There is no power of storage, and although this is not so necessary for steadiness when large amounts of power are being supplied, the absence of it necessitates the engines being run continuously whether the load is small or large.

The question of danger which has been raised in connection with high-tension systems may refer, either to the danger of fire caused by short-circuiting or to the danger to human life. The former is not seriously insisted on as important in carefully organised installations. The real point is whether the accidents which have happened in connection with high-tension systems are sufficiently numerous to justify the public in regarding them as dangerous. Our opinion is distinctly the reverse. Practically, all these accidents have occurred in America, where installations are managed in a much less careful way than in this country. It cannot justly be concluded from such experience that high potentials should be prohibited in England as dangerous, any more than the occurrence of serious railway accidents in America could justify the prohibition of high speeds on our own railways. Moreover the number of casualties in America, caused by the use of high potentials, is small compared with those due to street accidents about which no notice is taken. The objection of danger is always put forth to delay the progress of every improvement the ultimate success of which is assured. Even if all the accidents reported were true, and had occurred in this country, the logical conclusion would be, not to prohibit such high potentials, but to insist upon the need for greater precautions in laying the mains and in ensuring better insulation. Danger to life depends not so much upon the electrical potentials employed as upon the quality of the electrical contact with the mains; for, if this contact be sufficiently good, even the so-called low tensions may become highly dangerous. The employment of mains of the Ferranti or concentric type obviates any danger, since the outer tube differs in potential very little from the earth, and this remains true even if the insulation between the tubes breaks down. It is too early yet to pronounce any opinion upon the durability of the insulation intended for such high potentials as are about to be employed at Deptford. Only practical experience can decide. At the same time mains have been made to endure for years potentials of over 2,000 volts, and there is no reason to think that they cannot be made equally successful with the higher potentials proposed. The success of the Grosvenor Gallery installation and its remarkable freedom from accidents is sufficient witness to the possibility of success of systems employing tensions of over 2,000 volts. The clamour which has arisen with regard to the dangers accompanying high-potential distributions is not, therefore, justified by the facts connected with carefully organised work.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

THE THEORY OF ARMATURE REACTIONS IN DYNAMOS AND MOTORS.*

BY JAMES SWINBURNE.

(Continued from page 375.)

REVERSAL OF THE SECTIONS UNDER THE BRUSHES.

As a convolution passes under a brush its current falls from the normal to zero, and then rises to the normal in the other direction, and the brush leaves the commutator strip just at that instant, else there would be sparking. To find what field the convolution must be passing through to produce this result, the variation of the number of lines of induction through the convolution must be found, and the time of short-circuiting known. Any lines of induction through the convolution must pass, 1st, round by the field magnets, thus taking the same course as the field-magnet induction; 2nd, through the armature and air gap in the same way as the field induction, and then from pole to pole across the external air like the field leakage; 3rd, through the iron of the armature in the immediate vicinity of the conductor, and round the conductor by the air (Fig. 5.) In a Gramme armature there are two more paths—4, like 3, only inside the armature ring, and 5, round the ring. The last is neutralised by the reversal of the opposite section, and if an uneven number of sections were used the closed armature circuit would damp it. As to the first, any variation of the induction of the field magnets would be damped by the closed copper field-magnet coils, not to speak of the closed armature coils forming the belt of back ampere-turns. In addition to this, if the current died away, and increased up to its normal in the opposite direction uniformly, the current-turns linked with the

* Read before the Institution on Thursday, February 13, 1890.

Digitized by Google

circuits 1 and 2 would remain constant, for on one side there is a constant increase of back current-turns, and on the other the reversed or forward turns are again crossing the lines 1 and 2. There could thus only be variation of induction round circuits 1 and 2 if the current in the section did not change uniformly. Any change in the induction round such a circuit as 2 would be damped by the Foucault currents produced in the pole-pieces, as the current is small and the frequency enormous.

The third course—3—may be treated as if the convolution were stretched out straight in air. The self-induction could then be calculated. As half the circuit round the wire is through iron, the self-induction may be doubled. The conductor may be taken as a linear conductor, and the self-induction of the active part taken within reasonable limits. To give some idea of the magnitudes dealt with, we may take, as an example, a drum armature of 15 cm. radius and 38 cm. length, with 120 external conductors, giving 100 volts and 400 amperes at 800 revolutions per minute. The self-induction of the active part may then be taken from 0·5 to, say, 5 cm. radius. Then

$$L = 38\int_{0\cdot5}^{5} \frac{4\,d\,r}{r} \times 10^{-9} = 350 \times 10^{-9}.$$

In a drum machine the neighbouring conductors belong to different convolutions, and in this case both are being commutated at the same time: the mutual induction of the convolution must therefore be taken into account. To calculate the coefficient of mutual induction would involve the calculation of the mean geo-

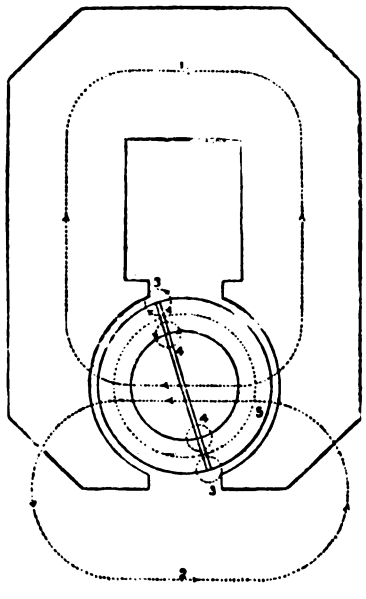


Fig. 5.

metrical distance. It will be near enough for the present purpose if the mutual induction is taken at

$$M = 38\int_{1}^{5} \frac{4\,d\,r}{r} \times 10^{-9} = 244 \times 10^{-9}.$$

The active part of the convolution may therefore be taken as having a self-induction of 594×10^{-9}. It is more difficult to get an idea of the self-induction of the end plates. The end plates are flat copper, probably 3 cm. or so wide; they are not close to the iron of the armature, but are among other plates, which lessen the effect. Probably $L_2 = 24 \times 10^{-9}$ for each end will be nearly correct. The coefficient of self-induction of a convolution is thus 1,236. The resistance of the convolution is ·000456 ohm. If the brush covers one section and a-half, the time of short-circuiting is ·001875. From these data the electromotive force necessary to bring the current to 200 amperes can be determined—

$$E = \frac{CR\epsilon^{-\frac{RT}{L}}}{1-\epsilon^{-\frac{RT}{L}}} + \frac{CR}{1-\epsilon^{-\frac{RT}{L}}} = \cdot274 \text{ volt.}$$

As the velocity of the conductor is 527 cm. per second and its active part is 76·2 cm., the field needed to reverse is $B_g = 685$.

It must be borne in mind that this calculation is at best only a rough approximation. In the first place, the field is not really uniform. In the second, the convolution has not really a constant coefficient of self-induction, as that depends on the position of the active part of the conductor in the field, and on the magnetisation of the iron in the armature in its immediate neighbourhood.

If the machine were made with two convolutions per section, and if the brushes still covered one section, it is obvious from the formula that the field necessary to reverse would be twice what it was before, if the self-induction is four times. As a matter of fact, the self-induction would not be nearly four times, for the conductors are too far apart. It would be somewhere between twice and four times.

If there were no self-induction the field necessary to reverse would be just enough to preserve a current of 200 amperes against the resistance of the convolution. If the brush surface were the same the convolution would be short-circuited for, say, 1-40th of a revolution. The loss of power would then be 28 watts. The self-induction prevents the current reversing instantaneously, and makes it change gradually. This reduces the power to about one-third, so 18 watts is about the loss of power due to the short-circuiting of the convolution. The self-induction of the section is thus instrumental in preventing waste of power.

The field necessary for the reversal of the current in a section being known, the position of the brushes can be determined.

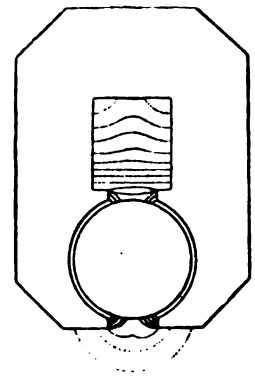


Fig. 6.

If the armature had no current the field would fall off very quickly round the armature after emerging from under the pole-pieces. At no load, for instance, the disposition of the lines of induction is, roughly, as shown in Fig. 6. In this case the lines that enter the armature are all cramped together at the pole corners. The lines leaving the shanks of the magnets pass right across and do not enter the armature at all.

If the cross current-turns are alone considered, a disposition, roughly, as shown in Fig. 7 is obtained. There are no lines across, so the lines are cramped together where they leave the armature only. If Figs. 6 and 7 were superposed, the opposite inductions

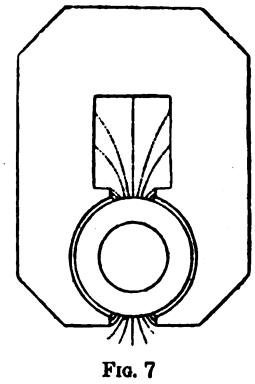


Fig. 7

would be equal quite close to the leading pole corners. The exact position would be difficult to determine, but by such a rough method as that just described the position can be found so as to make no sensible error in the calculations. Fig. 8 shows the disposition of the induction due to the back current turns. Those going right round the field are left out, for their disposition is almost exactly the same as that of the field lines, and they are cancelled by some of the series winding. If Fig. 8 is superposed on Fig. 6 or 7, the induction is increased on one side and decreased on the other. On each side of the centre line the addition or subtraction is uniform. It is clear, then, that except in the case of very small machines, or machines with very light loads, the position of non sparking of the brushes is close under the leading pole corners. In practice, this is easily verified by taking two pilot brushes and a detector, and finding the position of no deflection when one is slightly in advance of the other.

Digitized by Google

A glance at actual machines shows that the conclusion here arrived at theoretically—that the brushes are almost under the leading pole corners—is correct. The angle of lead of brushes at full load thus depends on the pole angle, and the back potential, Ω_b, can now be given in the form $(\pi - \theta)\, n\, C/10$.

Equation (5), for the full load excitation, can therefore be written,

$$\Omega_{a-m} = l_a B_a/\mu_a + (\pi - \theta)\, n\, C/10 + g\, B_g + l_m B_m/\mu_m \quad . \quad (8)$$

Equation (2), for the cross-sectional area of the field magnets, also becomes, in full,

$$A_m = 2\, a\, b\, \frac{B_a}{B_m} + r\, \frac{l\, B_a/\mu_a + g\, B_g + (\pi - \theta)\, n\, C/10}{M\, B_m} \quad . \quad (9)$$

Probably the greatest problem that still remains to dynamo makers to grapple with is that of lessening or avoiding sparking at the brushes. At present it is necessary to move them whenever the

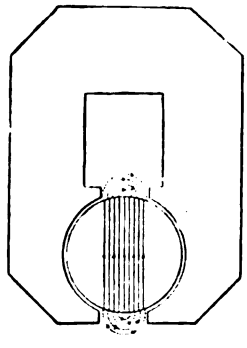


Fig. 8.

load of the machine is altered. Several methods of moving the brushes automatically have been proposed, and perhaps used, in the United States, but they have not come into common use in this country. An attendant is therefore necessary if the brushes are to be kept in good order. Fig. 9 shows a few turns of a winding specially designed to need very little moving of the brushes. A convolution, instead of being wound over the armature diametrically as usual, is wound over the core so that one side of it gets into the field just as the other side is coming out. At no load the convolution is commutated when the sides are at equal distances

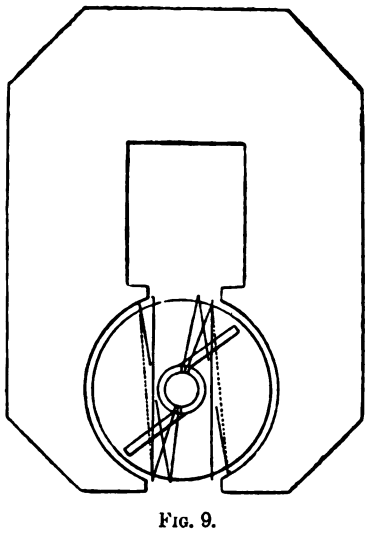


Fig. 9.

from the pole-pieces. At full load a very small movement of the brushes is enough to bring one side out of the field and put the other side in far enough to reverse the current. If the brushes are not shifted, the conductors in the belt between the pole-pieces have current in alternate directions, so that they do not act as the coils of an electro-magnet; the cross induction just under the pole corners is, however, the same. As the lead of the brushes is very small, the back current-turns are small also. As the change of field is rapid, it is necessary to use very narrow brushes at light loads, while there is sparking if there is the least inaccuracy. This winding is not perfectly suitable for very large machines with single magnets, for one conductor has its current reversed by the top leading pole corner, and the other by the lower one, and, as already explained, the top is generally stronger, so that more lead is needed on the bottom brush, and this is troublesome. In small machines this does not take place to the same extent.

In some types of machines made in the United States a series coil is wound round the armature instead of on the field magnets. It is then sometimes wound obliquely, so that it lies against the two trailing pole corners. The idea in arranging it obliquely is, no doubt, to counterbalance the obliquity due to the armature current in some way. If the series coil is wound on the armature, it must have enough ampere-turns to counterbalance the back current-turns on the armature, and, in addition to this, enough to increase the armature induction enough to allow for the armature resistance at full load. In a large machine, therefore, it is equal to but little more than the back current-turns. As it is arranged obliquely, it also counteracts part of the cross current-turns; but as the cross current-turns are always much more numerous than the back current-turns, the series coil in this position lessens the cross induction to a very small extent. This arrangement has therefore little advantage.

As a very weak field is enough to reverse the current in a section, a small pole-piece might be so applied to the armature as to reverse the sections at any convenient place. If the reversal could take place in such a position that the brushes would have a negative lead, the back current-turns would be converted into forward current turns, and a machine could be designed to give constant electromotive force, or even a higher electromotive force at full load, without any series winding on the magnets at all. Reversing pole-pieces, as they are called, were brought out some two years ago. Fig. 10 shows a simple case. Two reversing pole-pieces are shown. In order that there may be some induction in the same direction as that in the left limb of the magnet, it is clear that the line integral of the magnetic force from A to B must be positive. If the brushes are under these reversing pole-pieces the line A B passes through the neutral points, and the cross potential is $\pi\, n\, C/10$. Each reversing magnet must therefore have $\frac{1}{8}\, n\, C$ ampere-turns on it to counteract the cross current-turns, and a few more to cause the reversal. In large machines these pole-pieces are thus difficult to work in.

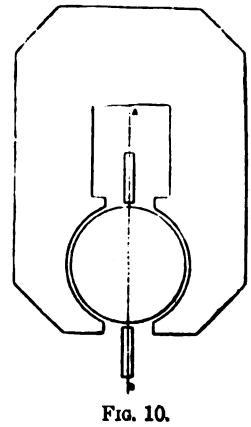


Fig. 10.

In a drum armature it would not be necessary to have two reversing poles; one wound with a little more than $\frac{1}{8}\, n\, C$ ampere-turns would be enough. Of course these poles should have their coils in series with the armature, so that their excitation varies with the cross-current turns.

If the reversing pole-piece A is made larger, and attached to the yoke, the same number of current-turns is necessary, as the yoke is at the same magnetic potential as the centre of the armature, if the magnet limbs have equal coils, and the left pole-piece is not highly magnetised. As the reversing pole needs no excitation at no load, the shunt must be wound on both limbs equally. But the series coils may all be wound on one limb so that the yoke is not at the same potential as the centre of the armature at full load. Suppose the series coil has $n\, C/16$ ampere-turns on each former, with no reversing pole-pieces, the whole may be put on one former, and the reversing pole-piece then requires but little wire on it. But the reversing pole-piece does away with the need of much series winding on the fields, so there would not be anything like these series current-turns to be arranged at pleasure; in fact, if the reversing pole-piece were put on one side, so as to give negative lead to the brushes, there would be no need of any; and for this reason the reversing pole-piece is, in large machines at least, somewhat impracticable.

Fig. 11 shows an arrangement in which a small horse-shoe electro-magnet is arranged against the uncovered part of an armature. The horse-shoe, as a whole, provides a convenient path for the line of induction due to the cross ampere-turns. If the electro-magnet has more ampere turns on it than there are on the part of the armature covered by it, one pole of it will act as a reversing pole-piece. This electro-magnet is a little difficult to attach to the dynamo so as not to cause excessive magnetic leakage, as the sides of it come near the main poles of the dynamo.

Digitized by Google

Fig. 12 is a diagram of another method. The armature proper is made as usual, but the connections to the commutator pass over the outside of a sort of subsidiary armature core. The electromotive force needed for reversing a section is induced in the connection by a subsidiary field-magnet with narrow pole-pieces, as shown. The little field-magnets are wound in series with the main circuit. The connections are shown embedded in the core as in the notches of a Pacinotti armature. A small yoke is shown in Fig. 12; in practice the subsidiary magnets would be mounted on the bedplate.

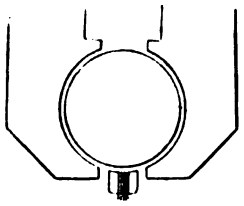


Fig. 11.

Fig. 13 shows an arrangement in which the subsidiary magnets are mounted on the rocker that holds the brushes, so that the machine can be regulated by moving the brushes backwards or forwards without producing sparking.

It is probable that some form of reversing pole-piece will come into general use, so these forms are described at length.

The advantages to be gained by such an arrangement are very great. The brushes do not need to be shifted as the load varies, which saves attendance and wear. Back current-turns are avoided, and this reduces the expense in the series field windings, and saves

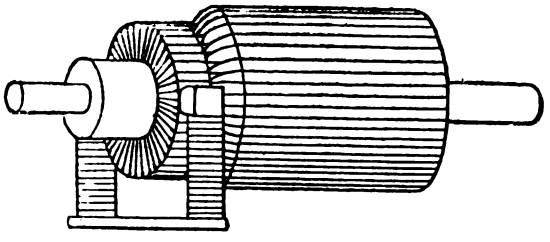


Fig. 12.

power now wasted in them. The field magnets can be made smaller, and the induction in them will be the same at full load as at no load, so that the electromotive force will not be unstable at light loads—a state of things which is not always avoidable at present.

A smooth-surface commutator, such as is generally used in low-tension dynamos, is seldom used on machines for arc lighting. No doubt the reason is this: An arc light machine must be series-wound, because it would be too expensive to wind the field magnets with small enough wire to act as a shunt. Though series-wound, it

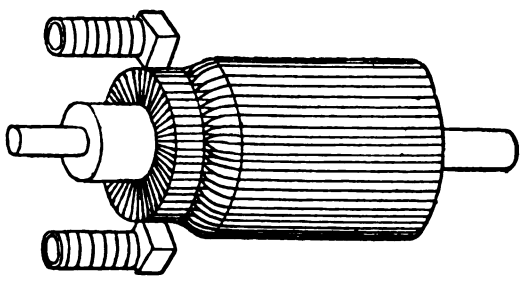


Fig. 13.

must be arranged so that any increase of current is accompanied by a decrease in the electromotive force, or the lamps would flicker. The point of no sparking, therefore, shifts forward when the current increases, and backwards if the current decreases. There must be a large number of turns per section, so that the least movement of the non-sparking point causes sparking at the brushes. If the current of the machine increases above the normal, so that the brushes are no longer far enough forward to avoid sparking, the spark caused remains as a small arc till the current in the conductors of the section comes to the normal, and then disappears. If the machine current falls below the normal, the current in the section will have increased beyond the armature current, and the arc so formed may continue long enough to burn the commutator sections, or even to flash round. In machines with very few commutator sections the brushes are always given too little lead, otherwise there would be a flash round every time the current fell below the normal. No doubt this is why the practice in arc light machines is to use few commutator sections, to leave a small air space between them, and to give the brushes less than sparkless lead, so that the sparks then form between the end of the brush and the edge of the section, and do not destroy the surface of the commutator, and do not flash round. In spite of this, however, arc light machines have been made for some time with continuous-surface commutators.

Gramme and Drum Armatures.

The drum armature was invented by Worms de Romilly, and in 1872 an account was published in *Les Mondes*.

First, as to winding. If a given armature is wound Gramme or drum, with a given number of external turns, there is less resistance in the drum, unless the armature is of very large diameter in proportion to its length. If the discs are made specially for a drum armature, a greater radial depth can be allowed, as the space used for inside turns in the Gramme can be utilised for iron.

If the radial depth of the disc is greater, and the induction in the iron of the armature is the same, the induction in the air-gap is greater. This takes heavier field-magnets and more excitation, but increases the output of the armature. In addition to this it admits of more armature current-turns, as the cross induction can be increased also without reversing the induction under the leading pole corners. With a drum armature a very much larger single-magnet machine can therefore be built than with a Gramme.

Each section of the Gramme machine has a higher resistance than that of a drum with the same number of commutator sections. If a given armature is wound Gramme instead of drum, the self-induction is about double for each external turn, because the conductor also makes a little field of its own inside the armature, as in Fig. 3, being close to the iron, and the self-induction due to that would be about equal to that of the active part of the conductor. Two turns per section make the self-induction from three to four times as great as it would be with one turn. There is no mutual induction between the conductors in connection with the opposite brushes, as in a drum machine, so the self-induction in the Gramme may be taken as twice that of the drum. The Gramme may, however, be made with twice as many commutator sections, giving one turn per section. The self-induction of a section is thus greater than the self and mutual induction of half a convolution in the drum, and the resistance is also greater. The Gramme therefore, still requires a stronger reversing field. The effect of this is that a small displacement of the brushes—or, what is the same thing, a small variation of the load—causes a greater spark at the tip of the brush. If the armature is perfectly symmetrically made a position of no sparking can be found for any given load with a large number of turns per section, but the least variation of load or movement of the brushes will then give rise to sparking.

The Gramme has still another great disadvantage when used in large machines. The current-turns on the armature bring the sides of the internal hole to a considerable difference of magnetic potential, and this causes induction in the spindle, and heats it. This not only causes waste of power, but frequently the heat is conducted to the bearings and initiates hot bearings in addition. In a drum armature the sides of the inside hole have only a difference of potential of $l_a\ B/\mu_{a'}$, as the armature current-turns do not affect the spindle. The armature can generally be made of such radial depth that it is slightly magnetised, while a Gramme armature is generally taken up as high as consistent with keeping cool and economy of field-wire. The induction due to the back turns in the central hole in a Gramme machine introduces a correction in the size of magnet iron, as it acts as waste field. The induction in the hole is really oblique, and is due to the whole of the armature current-turns, so that the leakage is often very serious.

The drawbacks to the drum armature are all mechanical. In small drums the difficulty of winding, the want of ventilation at the ends, and the difficulty and expense of repair, more than balance the advantages of small resistance and little wire, or large output.

In large machines the same drawbacks appear, but they are of less relative importance. Without doubt the large dynamo of the future will be a four-pole or six-pole drum. By using four poles a much larger machine can be made without trouble from cross-induction. The end connections, which are the greatest difficulty, then become much simpler, and any part of any convolution can be taken out for repair without disturbing the rest of the conductors. The central ventilation hole is much larger, as the radial depth need only be half what it is in a twofold machine.

Relation of Motors to Dynamos.

Having discussed the full theory of dynamos, its application to motors is, of course, exceedingly simple. A motor is nothing but a

Digitized by Google

dynamo running the other way, as a dynamo is a practically reversible machine.

Fig. 14 shows a dynamo armature with the position of the brushes and the back and cross armature windings. For simplicity the brushes are shown as touching the outside of the armature instead of the commutator.

Suppose the direction of the currents in the field and armature to remain the same, but the direction of rotation of the armature to reverse, the dynamo then becomes a motor. The brushes must be inclined the other way, as shown dotted, otherwise the ends would catch in the commutator. The cross and back turns remain as before, so that the armature current opposes the field excitation. The brushes would be in exactly the same place in the motor as in the dynamo if the field where the commutation takes place were uniform. As a matter of fact, it is stronger near the pole corner, so a motor has a very little less lead. It has sometimes been said that the armature current assists the field in a motor, but this can only take place if the brushes are given a negative lead. The same result is obtained in a dynamo by putting the brushes back; but in both cases, of course, this leads to excessive sparking. It is sometimes imagined that some effect of the convolutions being commutated acts differently in a motor, but a glance at the diagram shows that the action is completely reversed. The section being commutated in a dynamo, opposes the movement of the armature; in a motor it assists the armature. No appreciable Foucault currents can be caused by the reversal of the section. If any were, they would assist the dynamo and oppose the motor, so that they would also be reversible.

Most writers on dynamos speak of loss of electromotive force and loss of power by "self-induction of the armature." This is often supposed to amount to about 5 or 10 per cent. There must

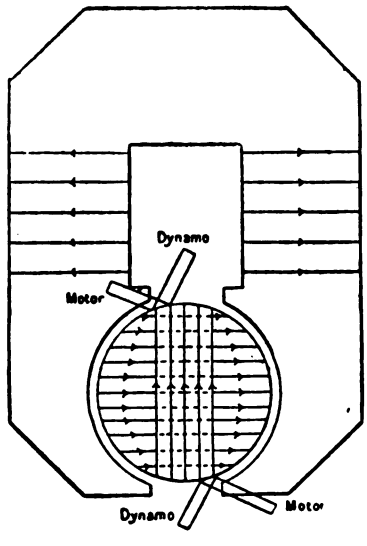


FIG. 14.

be some misunderstanding about this, as there is no way in which such a loss could take place. The current in the armature is sensibly constant except in the section being commutated. In any case power cannot be lost by self-induction.

There is, then, no point in which the dynamo is not perfectly reversible, except a merely theoretical difference in the position of the brushes, and there is no foundation for the idea that a motor should have a large armature and a weak field. In so far as any motor departs from the design of a good dynamo, it is bad.

Of course the winding of the field-magnets in a motor is different.

The winding and design of magnets of motors have received but little attention. Suppose a motor is to run at constant speed on a constant-potential circuit. The shunt excitation is

$$\Omega_s = l_a B_{ao}/\mu_o + g B_{go} + l_m B_{mo}/\mu,$$

the suffixes o and f showing reference to full or no load.

At full load the armature induction must be reduced so that the full-load current passes. If E is the terminal electromotive force, and R the armature resistance, the armature induction at full load $B_{af} = B_{ao} \frac{E - CR}{E}$, and the gap induction is also reduced in the same proportion. The full-load magnetic potential of the field coil is

$$\Omega_{s+m} = l_a B_{af}/\mu_a + (\pi - \theta)(n C/10 + g B_{gf} + l_m) B_m/\mu_m \quad . \quad (8)$$

The alteration of the first and last terms makes so little difference to the value of Ω_{m+s} or Ω_s that it may be disregarded. The full-load excitation is thus increased by $(\mu - \theta) n C/10$, and decreased by the difference between $2 g B_{go}$ and $2 g B_{gf}$. That is to say, extra field excitation is needed to counteract the back current-turns on the armature, and less excitation is needed to produce the reduced air-gap induction. If these are equal, the machine will keep constant speed when shunt-wound. In a small or slow machine the armature loss is large; in a large one the back induction is great. A small machine, therefore, needs backward-wound series coils, and a large one forward-wound. If $(\pi - \theta) n C/10 = g B_{go} - g B_{gf}$, the shunt ampere-turns needed at no load and full load differ only by the difference of excitation needed to magnetise the iron of the field-magnets and armature. Unless the machine is very small, the difference in the armature and field induction is not important. It tends to make the motor run slower at full load, and this may be taken into account where very exact work is needed.

As the field induction in a motor is highest at no load, the area of cross-section is

$$A = 2 a b \frac{B_a}{B_m} + \frac{r \Omega_p}{M B_m} \quad . \quad . \quad . \quad . \quad . \quad (2)$$

it is thus somewhat smaller than in the case of the corresponding compound-wound dynamo.

As a shunt machine is simpler to make than a compound, and as a differentially wound motor may start backwards, shunt-winding is preferable. Within wide limits of size constant-speed motors can be designed with simple shunt-winding. All that is needed is to make Ω_b equal to $g B_{go} - g B_{gf}$. $\Omega_b = (\pi - \theta) n C/10$, and $B_b = \frac{2 a b B_a \pi}{(a+d)(r+\frac{1}{2}g)\theta}$, where d is an allowance for fringe, and θ is also made a little large to allow for fringe. This gives

$$\pi\theta - \theta^2 = \frac{20 a b B_a \pi}{(a+d)(r+\frac{1}{4}g) n C} \quad . \quad . \quad . \quad . \quad (10)$$

This appears complicated, but when the symbols are replaced by numbers for an actual machine, of course it is quite simple. It will be found that in very small motors this makes the pole angle too small, while in large machines the pole-pieces would embrace the armature so much as to cause excessive magnetic leakage and reversed induction under the trailing corner, unless the pole-pieces are designed to obviate this.

A properly designed direct-current motor has also the very convenient property of running at approximately constant speed, even if the electromotive force on it varies. If the field and armature are not highly magnetised the armature induction varies approximately as the electromotive force on the shunt. The armature induction, and, consequently, back electromotive force, of the machine thus varies as the electromotive force on the mains, which is just the condition wanted for constant speed. A direct-current motor will therefore preserve approximately constant speed, not only with varying load, but also with varying electromotive force.

SMALL AIR SPACE DYNAMOS.

There is a type of machine that has not yet been much studied; that is the dynamo or motor in which the gap is kept small, being merely a mechanical clearance to allow the armature to rotate.

Obviously, as the air space is small, the magnets will need very little excitation, and there will be no waste field to speak of; so the magnets may be made exceedingly small and light, though that does not appear to have been generally realised. The Pacinotti is the best known form of this machine, the Brush being a good example. The drawback to the Pacinotti armature is that it gives rise to Foucault currents in the field-magnets, and for that reason it is not generally used now, though the difficulty is sometimes overcome by making the teeth small and numerous.

Machines with the armature wires wound through holes near the periphery have been made on the Continent, but apparently with the view of increasing the armature induction by reducing the air space. This form, however, admits of very small field magnets with very little excitation, so that it is specially adapted for machines where extreme lightness is needed.

At full load, however, a trouble arises in small-gap machines. As the air space is very small, the cross induction is very great, and so the induction under the leading pole corner is reversed. Of course there is a position of the brushes with no sparking, but it is very far forward, more especially if the speed is very slow, as the self-induction of each armature section is then considerable. The result is that the back current-turns are very great, and so the field magnets necessary for full load are not so very small after all. If the dynamo is running at a very slow speed—such, for instance, as a motor on a tram-car at 200 or 300 revolutions—the brushes may be allowed to spark, as the sparking will be small, and given no lead, or just enough to preserve constant speed. This form of machine is suitable for the application of reversing pole-pieces. It was shown that in any ordinary machine the difficulty of designing reversing pole-pieces arises from the difference of magnetic potential between the pole-pieces and the armature. In this machine the

Digitized by Google

difference is very small, so reversing pole-pieces can easily be applied.

In the case of the Brush machine the cross induction is enormous, and the back current-turns are therefore enormous too. The result of this is that the lead of the brushes is very great. Such a machine may be short-circuited without any dangerous increase of current. In fact, it has been used for charging batteries for train lighting at varying speeds. As the speed increases the current tends to increase, and reduces the armature induction enough to keep the current within safe limits, even if the speed is increased several fold.

The excessive heating of the trailing pole corner in the Brush machine has given rise to many speculations. It has generally been assumed that the heat generated there is no greater than at the leading pole corner, but that it is additionally heated by the hot air from the armature. It is more probable that the excessive heating is due chiefly to increased Foucault currents. As the brushes have considerable lead, the coil leaving the trailing corner is not in parallel with the other, so that the heating by Foucault currents in the trailing corner would be nearly four times as great as under the leading corner where two coils are in parallel. The iron is probably too highly magnetised to allow the induction to vary quite so much as this, and as it is cast iron the resistance prevents the heating being still greater. The trailing corner is also very highly magnetised, while the leading probably has its magnetism slightly reversed. The heating from variation of magnetisation at the trailing pole corner is thus much greater, especially when the enormous magnetic force is considered, and the frequent passage of the armature notches. A 40-lighter has something like 120 per second.

As a Brush machine has very little air space, the shunt is very small, so that the compound machine is chiefly wound with series wire.

Correction in Testing Gramme Machines.

In the method of testing machines by running them as motors at no load, the machine is run as a motor with the armature induction the same as at full load. The power taken to drive it gives the stray power, *i.e.*, the loss of conversion. To this is added the loss by resistance in the armature and fields, and the efficiency of the dynamo or motor is thus calculated. The stray power consists of loss by mechanical friction, the loss by reversal of magnetisation, and loss by Foucault currents, and it has been assumed that these remain constant if the armature induction is constant. The theory of armature reaction, however, points to a few corrections. The loss by Foucault currents in the armature conductors is greater at full load than no load, by at most 33 per cent. The loss by reversal of magnetisation may also be slightly greater, as the induction in some parts of the armature may be greater. The loss by Foucault currents in the discs is slightly greater, but as this loss is exceedingly small, that does not matter. These increased losses are of little more than theoretical importance, but it is as well to point them out. If the machine is a large Gramme, the heating in the centre is largely increased at full load, so this method of testing does not give perfectly reliable results in the case of such large machines. For small machines and large drum machines it is very convenient.

This Paper has been devoted to direct-current dynamos, as the corresponding treatment of alternating-current machines is, perhaps, hardly ripe for discussion yet, though it is of enormous importance, as the whole theory of running machines in parallel, and of alternating motors, depends upon it.

After the reading of Mr. Swinburne's Paper, it was announced that at the next meeting (Thursday, February 20th), Mr. W. B. Esson would read his communication on "Some Points in Dynamo and Motor Design," and that the two Papers would then be jointly discussed.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

New York, *February* 8, 1890.

The Gas and Electric Light Statistics of Massachusetts.—Some interesting statistics on the subject of gas and electric lighting have just been published in the fifth annual report of the Board of Gas and Electric Light Commissioners of Massachusetts. It is generally known that the electric light is a favoured illuminant in the New England States, but it will occasion general surprise, I believe, to state that there are more electric light and power companies in Massachusetts now than there are gas companies. Probably this can be said of no other part of the world, although such a state of affairs may be closely approached in some other of our progressive commonwealths, such as New York, Pennsylvania, Illinois, and Nebraska. It appears that in Massachusetts there are 100 electric light companies and 75 gas companies; while of these 75 no fewer than 26 have obtained the power to supply electricity as well as gas, so that they should really rank as electric light companies. It appears, moreover, from these figures that in the department of public lighting, electric lights are steadily displacing the gas lamps, and the coal gas companies are shown to have lost just upon one thousand lights from this cause during the year. Summing up the figures roughly, they show that there are about 83,000 incandescent lamps in operation in the State, and about 11,500 arc lights. These figures are more significant when it is remembered that the Commissioners are a body vested with quite considerable powers in the way of checking irresponsible competition; in other words, when they are satisfied that a community is supplied with adequate agencies for producing light and which are furnishing light at a reasonable rate, they can prevent the starting up of new competition, which would lead at once possibly to a reduction of rates, but which very probably would ultimately result in a combination, when the community would have to pay higher rates permanently on the consolidated capital. Hence the electric light statistics are those of a solid, stable industry.

New Applications of the Electric Motor.—There is considerable activity in the electric motor field, not only in the direction of new motors, but in the applications to a number of industries. An event which has attracted no little attention in Chicago recently, and is being commented upon by the mechanical journals of the country, shows what the gain in convenience sometimes may be where resort is had to the motor. A large printing establishment in that city was suddenly deprived of its power by the complete wreck of its engine and boiler from a boiler explosion. Had it been necessary to wait until new boilers could be set up and the engine repaired, the company could not have resumed operations for several weeks, and the delay would have been attended with serious loss not only to the company but to their customers and *employés*. As soon as the situation was fairly grasped, however, it was decided to put in a 40 horse-power Thomson-Houston motor and to connect it to the main shafting. This was done: the circuit was run to the motor, and the whole printing establishment was started again in a day. It is such an exemplification as this of the handiness of electric power that recommends it so generally for all manner of industrial uses. Among the new motors which have just been put upon the market may be mentioned the small Crocker-Wheeler for incandescent circuits. Hitherto, in small motors of this kind, the practice has been in varying the speed to throw in a resistance in the main circuit, consisting usually of a lamp mounted on the top of the motor. By means of a new winding and switches to correspond, this necessity is avoided, and the speed can be varied between 1,900 revolutions full speed, and 950 half speed, without any loss in efficiency. It is interesting to mention that owing to the care with which this motor has been worked out and built, the speed can be employed as an indicator of the pressure on the circuit. Thus, if the speed of the motor is much greater or much less than is marked on the name-plate, that fact shows the circuit to be unsuited for it. This may then be determined quite accurately by counting the speed of the motor when oiled and run with the belt or load thrown off. It then runs 200 revolutions faster than the speed given off on the name-plate, and any difference from that speed shows that the circuit is of correspondingly higher or lower E.M.F. Thus a motor marked 110 volts, 1,900 revolutions, should run free at 2,100 revolutions. If it run free at 2,000 it shows that the circuit is only about 105 volts, and should be altered accordingly. Another interesting little feature is the simplicity of change of direction of rotation. All that is required is merely a change of the position of the brush-holders, putting the upper one below.

Among the newer applications that have recently been brought out is the Kinsman ice-cutting machine. As you are probably aware, ice-cutting is quite an industry in this country when there is any ice to cut, and, in point of fact, there are several sections of the far North which depend on the ice crop just as much as do our Western prairies on their wheat crops. So far, the horse has been the general source of power for running the ice-cutting machine, but it seems as though electri

Digitized by Google

city is likely to enjoy some popularity in this field, especially as very large numbers of the ice companies operate electric light plants, so that, when ice-cutting is actually going on, all the ice may be gathered in, day and night, before the thaw comes and the ice gets too thin to be of much use. It is evidently very easy to take the same generating plant and to run it for motive-power purposes during the day. The apparatus rigged up by Mr. F. E. Kinsman, of this city, consists of an electric motor, suitably mounted upon a pair of spurred wheels, upon the inside of which is placed a ring gear. The shaft of the motor armature is of sufficient length to allow the small pinions on its ends to engage the ring gear for the purpose of propelling the carriage or carrier. Upon this armature shaft are placed the cutters or saws in gangs as required. There is thus a fixed relation between the progress of the carriage and the speed of the knives or groovers, the same being true of the cable drums, whose shafts for obvious reasons carry a much larger pinion than the armature shaft. These drums pay out a specially constructed cable or conductor, so as to follow the motions of the machine, back and forward. This machine, all told, weighs less than a good-sized horse, and at the same time has the advantage of having its weight better distributed, proceeding also without shock or pounding. It requires but one operator, and is easily moved about from pond to pond. It is claimed that a 2-knife cutter can do the work of 25 horses, each requiring a leader and a ploughman. Thus you will see that in the near future the average American citizen will not only be fanned electrically in the heat of the summer days, but sip cool drinks for the ice of which he is also indebted to electric power.

Electric Railroad Development.—The continued extraordinary mildness of the winter has had a most stimulating effect on the electric railroad industry, and from every quarter one hears of great progress in this direction. I made reference recently to the action of the Minneapolis Street Railway Company in throwing aside a cable plant worth $400,000, quite new, and substituting electricity. The company has now ordered a large number of cars from the Thomson-Houston Company, and the work will be proceeded with without delay. It is stated that the order from St. Paul and Minneapolis for electric railway work given to the Thomson-Houston Company aggregates two million dollars. This, however, is only the initial equipment, so you will see that in this country the business is already going into large figures, such as may fairly be compared with those of the long steam roads. Speaking of steam railways reminds me that in Cincinnati, where the electric railroads have been working very successfully, a proposition has been seriously discussed by the local papers to run the suburban trains into the city by means of electric power, thus doing away with the various objections that prevail against the use of steam within the city limits. I should not be surprised to see some such change made in Cincinnati at an early date. When people once begin to discuss such matters in this country, they are not satisfied, as a general thing, until the change is made.

The Production of White Lead by Electrolysis.—An interesting process has recently been made public by Mr. T. D. Bottome, for the production of white lead by electrolysis. His process consists in electrolytically dissolving a lead electrode in an electrolyte containing nascent or free carbon dioxide, whereby the lead compound formed by electrolytic action is precipitated to form hydrated carbonate of lead, or pure white lead. It is, of course, necessary to have the bath replenished with additional carbon dioxide as the process continues. This can be done in several ways, a convenient one consisting in burning limestone, washing the gas produced by the dissociation of the constituents of the limestone, and supplying the gas directly to the bath. The white lead is from time to time removed from the tank, washed, and dried; and upon mixing with a suitable vehicle into a paint, it is found to have much greater covering properties than ordinary commercial white lead formed by dissolving lead in acetic acid in the presence of carbonic acid, since the latter is slightly crystalline and less opaque than the hydrated carbonate produced by the action of carbonic acid on plumbic acid. The samples of this white lead are remarkably good, being an extremely fine powder, the result of a simple drying by spontaneous evaporation, in marked contrast to the white lead obtained by the old acetic acid process, which has to be ground up mechanically before it can be used. Mr. Bottome figures that, with power at $55 per horse-power a year, 50 cents a ton for the electric current would cover that item in the making of white lead. Upon this and various other data—which, however, include the somewhat specious element of "valuable by-products"—he claims that it is cheaper to produce the white lead this way than by time-honoured methods. It is to be hoped that this may prove so, for the resultant material is undoubtedly far above the average.

The Convention of the National Electric Light Association at Kansas City.—A good deal of interest is taken in the Convention of the National Electric Light Association which takes place at Kansas City next week. Although it is mid-winter, there is no question as to the large attendance at the Convention, as Kansas City is the centre of a remarkably wealthy and progressive district, and touches a large territory which is still practically unoccupied in an electrical sense. It is worthy of note that the headquarters of the Convention will be established at the Coates House, built by one of the pioneers of the city, Colonel Coates, who was largely interested in the introduction of the Edison electric light in Kansas City. It deserves mention, as evidence of the perfect faith of this man in the future of electricity, that when he built his fine hotel in 1886 he had it wired throughout for incandescent lights, and refused to have a gas-pipe placed within the building. At the present time Kansas City has half-a-dozen good electric light plants, including a large Thomson-Houston station and a large Edison station. It is also becoming an excellent centre for the distribution of general electrical goods, so that one or two supply houses have already been started there.

A Demand for Electric Traction Data.—The Western Electric Railway Association held their meeting in Chicago last week, and at that time appointed a Committee to compile such statistics as could be obtained covering the operation of electric railways in this country. The first thing that they wished to ascertain, on the testimony of representative superintendents of railway lines, was the comparative cost of operating by horses and by electric power. Another point was as to the mechanical repairs required on motor cars, with special reference to types of gearing and their relative efficiency, noiselessness, &c. The third point was as to repairs required in the electrical apparatus and the overhead circuits. Another matter they wished to determine more clearly was the comparative depreciation in value between lines operating electrically and by animal power. Yet another point of no small importance was one with regard to the prevailing value of safety breaks and the results obtained with them, as well as the cost and the nature of their material and construction.

CORRESPONDENCE.

THE ECONOMIC RATIO OF A TRACTION SYSTEM.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I notice in your issue of January 17th a correspondent raises some questions concerning the economic ratio of a traction system mentioned in some recent Papers of mine. If by the economic ratio I had meant to designate the dividend earning capacities of various motor systems, I should have been obliged to include a large number of variable factors quite outside of the question under discussion. Your correspondent points out that his own suggestion for the economic ratio is open to the same objection. I therefore confine myself to the ratio between total weight and useful load, taking into account the commercial efficiency of the motor system used. I included the weight of car in the useful load for the obvious reason that the car is necessary for the transport of passengers, and carring the car over the line is as necessary to earning dividends as carrying the passengers. If your correspondent will kindly suggest a method of seating passengers on material

Digitized by Google

particles, or "the meaning of words," I shall make no further reply to his criticism.

The form of economic ratio which I used was intended to mark the difference in the power supplied to a car by various motor systems, and for no other purpose. In certain cases it might be desirable to employ a ratio containing one or many other factors, and if the nature of the discussion required, I should not hesitate to do so.

As carrying on a discussion at a distance of 4,000 miles is not altogether convenient, I trust that this explanation will prove sufficient.—Yours, &c., LOUIS BELL.

Chicago, February 6th, 1890.

PROF. AYRTON'S PAPER "ON GALVANOMETERS."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your last issue, in giving an account of the discussion on the Paper on "Galvanometers" at the Physical Society on 7th inst., Prof. Ayrton is reported to have said:—

"The values in the case of No. 3 were deduced from Elliott's data obtained by testing with a Standard Cell which they believed to be a Daniell, but that it was quite possible a Grove cell might have been employed, as he believed this was Messrs. Elliott's usual practice."

On reading this, we wrote to Prof. Ayrton on 15th inst., asking him whether he had been mis-reported, but not having received any reply up to the present time we feel justified in assuming your report to be correct.

It is amusing to find that the learned Professor does not give us credit for knowing the difference between a Grove's and a Daniell's cell; but we may be allowed to express our surprise at the belief expressed by Prof. Ayrton, after a correspondence which took place between Mr. Mather (one of the authors of the Paper) and ourselves. On January 31st Mr. Mather wrote to ask if, in the values we had given, a Daniell's or a Grove's cell had been used, to which we replied that "For the last 25 years at least it has not been customary to use any other cell than the Daniell's in testing for the figure of merit;" and yet, in spite of this assurance, Prof. Ayrton maintains, and expresses his belief, that it is our usual practice.

The galvanometers whose values were tabulated were all given from tests made with a Daniell cell. We shall therefore feel obliged if you will kindly insert this letter in your next issue, in order that your readers, who, no doubt, to a large extent are also users of our galvanometers, may be made acquainted with the facts. We have little doubt that they will be more ready to accept our assurances than Prof. Ayrton seems inclined to be.—Yours, &c., ELLIOTT BROS.

101 and 102, St. Martin's-lane, London, W.C.,
February 20, 1890.

[We would refer our correspondent to a correction of our Physical Society report, which will be found in our Notes column.—ED. *E.*]

TELEPHONES FOR DOMESTIC USE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to your concluding remarks to the article on the above subject in your issue for February 14th, perhaps you will kindly allow me to point out that as you will observe from the enclosed copy of my patent specification No. 12,823, 1887, and Figs. 11 and 12 of the drawings thereto appended, there is no novelty in the automatic switch arrangement employed by the Telephone Construction and Maintenance Company in their inter-communication switch-boards, a precisely similar device being described in my specification.—Yours, &c., A. A. CAMPBELL SWINTON.

66, Victoria-street, S.W., February 14, 1890.

[*Extract from Patent Specification.*]

In order to make these switches automatically return to the normal position, viz., the position in which they should remain when not in use, the said switches may be provided with a spring or weight, tending always to make them return to this position, and a catch arrangement may be fitted to retain the switch in any other desired position, the said catch being so connected to a hook on which the telephone is hung, that the weight of the latter when hung up will withdraw the catch and allow the switch to return to its normal position under the action of its spring or weight.

Fig. 11 shows how this may be carried out, w being the telephone hook drawn up by the spring w^2, and resting when the telephone is on the hook upon a stop w^1. The lever of the hook w has a tooth w^4, engaging with

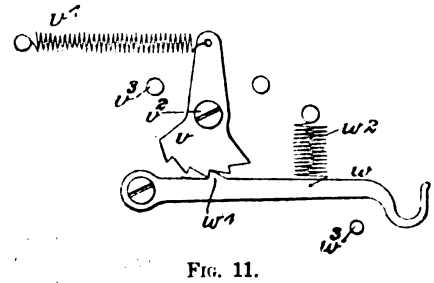


FIG. 11.

one or other of the teeth in a quadrant r, turning on a centre r^2, and provided with a spring r^4. When the telephone is off the hook the tooth w^4 engages with the tooth of the quadrant which is brought opposite it when the switch is turned. When the telephone is put on the hook the tooth w^4 releases the quadrant, and the switch is by the spring r^4 returned to its normal position. Or an arrangement similar to that shown in Fig. 12

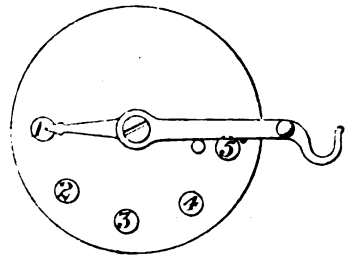


FIG. 12.

may be employed, the handle of the switch being made also the hook on which to hang the telephone receiver, and the arrangement being such that the hook is in a proper position to hang the receiver on it when it and the switch it operates are in the position that is required, as mentioned above.

[From our description (*The Electrician*, January 20, 1888) of a domestic telephone installation on Mr. Swinton's plan, it would seem, however, that no use was then made of this automatic device. "When the conversation is completed A replaces his plug in the A hole of his switch-box, so that other stations may be able to call him up if required."—ED. *E.*]

THE FULHAM VESTRY AND THE ELECTRIC LIGHT.

TO THE EDITOR OF THE ELECTRICIAN.

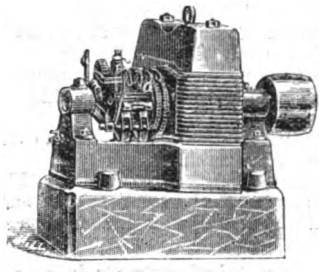
SIR: Yesterday's number of your valuable paper states that the Fulham Vestry have lodged objections to the two companies applying for Provisional Orders within their jurisdiction, because they do not consider the district at present ripe for electric lighting. Now, although this was mentioned incidentally as a reason, the actual determination of the Lighting Committee was to oppose any company obtaining either Licences or Orders, so that the Vestry may apply for powers and undertake the work itself. The Lighting Committee consists of 15 members, and meets weekly for the purpose of considering all questions of electric lighting in the parish. Reports as to the Vestry's powers, the requirements of the parish, and the eligibility of sites, have been received from the Solicitor, the Clerk, and the Surveyor. Each member has been supplied with the two Acts of Parliament, the Board of Trade rules, &c., and the Clerk has been ordered to place the current number of *The Electrician* on the table at each meeting of the Committee. We have also under consideration the lighting of our new Town Hall at Walham Green by electricity. In conclusion, I may add that the Committee have the sanction of the Vestry to obtain the assistance of an electrical engineer or expert to advise them generally on the subject, and are now seeking some one properly qualified for this purpose.—Yours, &c.,

RUSSELL SPOKES,
Member of the Lighting Committee
February 15, 1890. of the Fulham Vestry.

Digitized by Google

PARSONS AND CO.'S DYNAMOS AND MOTORS.

The annexed illustration shows the form of dynamo now being constructed by Messrs. C. A. Parsons and Co., of Newcastle-upon-Tyne. Great care has been taken in designing these machines to combine efficiency with strength and simplicity of construction, enabling them to stand rough usage without getting out of order.



These machines, which give good results as motors, are supplied with a simple form of brush-holder in which the springs usually employed are replaced by suitable balance weights, which have the advantage of ensuring the correct amount of pressure between the brushes and the commutator, with considerable saving in wear to both of these parts. Messrs. Parsons are also constructing machines of the inverted single horseshoe type, with similar improvements.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning.*]

"THE ELECTRICIAN"

ELECTRICAL TRADES' DIRECTORY & HANDBOOK for 1890

The new edition of our well-known Directory and Handbook is now ready. The book consists of 850 pages, and has entailed this year an exceptionally heavy amount of work. The HANDBOOK DIVISION contains a mass of most useful information. The DIRECTORY DIVISION consists of more than 400 pages, and contains a very carefully compiled Alphabetical and Classified List of Firms and Persons engaged in the Electrical and Allied Trades in all parts of the world. This Division has been corrected up to date, and the book is thoroughly reliable, even the very numerous changes which take place in the month of January being incorporated. The book is not a mere list of Members of Scientific Societies repeated again and again. The Colonial and Foreign Division will be found extensive and reliable. *Orders should be forwarded at once.*

MESSRS. DRAKE AND GORHAM.—This firm advise us that they are now acting on behalf of Messrs. Johnson and Phillips, of Charlton, as sole London agents for electric lighting and motive power. Their circular states that the electric light department at Charlton has recently been considerably enlarged to meet the rapidly increasing demand for dynamos and other electric light apparatus. Machines of the standard sizes will be kept in stock. The new accumulator department at Charlton is approaching completion, and Messrs. Drake and Gorham have secured the sole concession for the United Kingdom and Colonies.

DISSOLUTION.—The firm of Sydney F. Walker and Oliver, of Cardiff and Newcastle, telegraph and electrical engineers, has been dissolved.

AMERICAN CARBONS. — Messrs. Shippey Brothers (Limited) announce that they have been appointed European agents for the National Carbon Company, Cleveland, U.S.A., and that a stock of all sizes will be kept at their offices, 13 and 14, King-street, Cheapside.

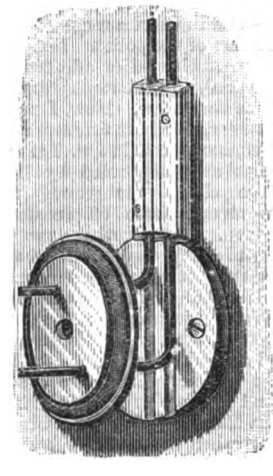
ZÜRCHER TELEPHONGESELLSCHAFT, ZÜRICH.—Dr. Albert Denzler has recently resigned the position of manager of this Company, and is succeeded by Herr Emil Bitterli, late chief engineer to the Company.

SALE BY AUCTION.—Mr. Alfred V. Robinson will offer some valuable property for sale at the Mart, Tokenhouse-yard, London, E.C., on Tuesday, March 4th, at two o'clock. The property comprises valuable leasehold electrical manufacturing premises, situated in Pownall-road, Hackney, London, together with dwelling house. Further particulars will be found on page 3 of our advertisements, and all information can be obtained on application to Messrs. Blackford, Riches, and Co., 25, Abchurch-lane, E.C.; or of the auctioneer, High-road, Tottenham, N.

AN INTERNATIONAL EXHIBITION OF MINING AND METALLURGY.—An exhibition will be held during the summer at the Crystal Palace, which has received most encouraging support. The Lord Mayor of London is patron of the Exhibition, and the Honorary President is the Duke of Fife. Among a long list of hon. vice-presidents are the names of Lord Thurlow, Sir Frederick Abel, C.B., &c., Sir Alexander Armstrong, K.C.B., &c., Sir Francis Dillon Bell, K.C.M.G., C.B., Sir James Kitson, Bart., Sir John Pender, K.C.M.G., Sir Edward J. Reed, K.C.B., M.P., Prof. W. Chandler Roberts-Austen, F.R.S., &c. Mr. W. Pritchard-Morgan, M.P., presides over the Executive Council, which consist of a number of gentlemen well known in connection with mining, metallurgical, and allied interests. The scope of the Exhibition will be wide enough to enable an interesting display to be made. Mining and scientific metallurgy, which now occupy such important positions in connection with modern industrial advancement, will have special exhibits, and one-half of the profits of the Exhibition is to be disposed of by the Council either in founding a scholarship at the Royal School of Mines, or in helping some other institution connected with mining and metallurgy, and the other half will be returned to the exhibitors. The hon. sec. is Mr. Geo. A. Ferguson, editor of the *Mining Journal*, 18, Finch-lane, London, E.C., from whom all particulars may be obtained.

IMPROVED BACK BLOCK.

Mr. Bathurst sends us an improved back block, the arrangement of which will be seen from the illustration. It consists of two pieces, the bottom one, which is grooved to correspond with the grooves in the casing, being screwed up flush underneath the end of the casing by simply sawing off a portion of the block to make it fit. This bottom block is the same thickness as the casing, and the grooves in the casing are continued in the block, so that the wires come right down into the switch, cut-out, or ceiling rose, and



are everywhere placed in wood without touching the plaster. The bottom block is covered by a polished mahogany or walnut cover, and the wires brought through as shown, and the casing cover fitted to the edge. The whole has a neat appearance, and the small extra cost of the double block is recouped by the saving of time and trouble. By using this back block in connection with Mr. Bathurst's "cross-over block" (*The Electrician*, February 22, 1889, p. 450) the wires in any installation are *everywhere* raised from contact with damp walls and plaster by the interception of dry wood.

BOOKS, &c., RECEIVED.

"Abstracts of Papers in Foreign Transactions and Periodicals." (Institution of Civil Engineers.)

"Journal of the Institution of Electrical Engineers." Vol. XVIII., No. 83. (London: E. and F. N. Spon.)

"Turning Lathes." Edited by James Lukin, B.A. Third edition. (Colchester: Britannia Company.)

"Traité des Piles Electriques." By Donato Tommasi. (Paris: Georges Carré.)

"Leçons sur l'Électricité." By H. Pellat. (Paris: Georges Carré.)

"Proceedings of the Royal Society." Vol. XLVI., No. 285; Vol. XLVII., No. 286. (London: Harrison and Sons.)

Digitized by Google

COMPANIES' MEETINGS & REPORTS.

India Rubber, Gutta Percha, and Telegraph Works Company (Limited).

The 26th ordinary general meeting of this Company was held on the 14th inst. at the Cannon-street Hotel, under the presidency of Mr. S. W. Silver.

The SECRETARY (Mr. William J. Tyler) having read the notice convening the meeting, the report of the Directors was taken as read.

The CHAIRMAN: We have much pleasure in rendering such an account to you of the operations of the past year, which shows a balance of £57,748. 9s. 1d. of net profits, making, with the amount brought forward from last year, a disposable balance of £62,036. 6s. 8d. Out of this we recommend a dividend of 10s. a share, making the distribution 10 per cent. for the year, and leaving £41,236. 6s. 8d. to be carried forward. The telegraph and electrical departments we have nothing special to report upon I think I informed you at the last meeting of the laying of the cables on the West Coast, and that work has been completed in the most satisfactory way. Our steamers have been partially employed. As regards the premises purchased in Liverpool, that is in consequence of the lease expiring; and in the interest of the Company we thought it better, to prevent any further interruption to the business, to purchase the freehold of the adjoining premises. The extension of the London warehouses is a matter which speaks for itself. Our general trading operations show about the same amount as last year. Notwithstanding the adverse circumstances which we have had to contend with, and with which you are all more or less familiar, but which have, I must say, prevented our participating in the general improvement in the trade of the country, our general trading has kept up to its highest point in amount. Now, as regards the strike at Silvertown, for its exciting cause we have not far to seek. The dock movement took place in the vicinity of our works, and affected a number of labourers there. These men were instigated by the clamour of professional agitators, and several irresponsible advisers, who, I think, would tell us now that they have seen their mistake. The demand made upon us by our *employés* for an increase in pay, notwithstanding that their wages were in excess of those paid in the locality, was refused. A combined attack was made upon those workers—who, I am glad to say, were in considerable number—who were inclined to pursue their daily vocations. The attacks upon them gave rise to picketing—that unmanly system—and in effect a reign of terror was set up. This may be traced to the inaction of the police. I have no hesitation in saying so, as in the later stages, when the police adopted more active measures, the whole movement collapsed, and the *employés* returned quietly to their work on the same terms as heretofore. Now, I must refer to our absent friend, the Managing Director, to whose firmness and sound judgment we must attribute this, for us, happy conclusion. Let me say that at considerable personal risk he was ably supported by his sons, by the whole staff of electricians, the clerks, the young men in the counting house, the foremen, a strong force of assistants, including several workmen and workwomen. The works were therefore kept going throughout. I should also say that from the outset Mr. Gray had the entire confidence and support of the whole Board, who were in perfect agreement with him. I should also add that throughout his long and active life it has been his one object and aim to see that those about him—I mean his workpeople—were justly and kindly treated. He remonstrated with the workpeople and reminded them of the terrible consequences which would occur to them, the whole of which have come to pass. We regret his absence: it is the first time we have missed him. He is seeking rest. In his absence his son Mr. Robert Gray will fill his place, and ably. I hope the time is not far distant when the era of strikes may be chronicled, and I have little doubt that what has taken place at Silvertown within the past year will form an important chapter, and I am sure that prominence in it will be given to the part taken by our friend, who is conspicuous by his absence from among us this day. I should not close these remarks without referring to the Persan works, but I will merely say that they have done good service for us. Without detaining you further I will now move:—

"*That the report and accounts now presented be received and adopted, and that a dividend of 5 per cent., or 10s. a share, free of income-tax, payable on and after 15th inst., be now declared.*"

Mr. NEIL BANNATYNE seconded the motion.

Mr. WEBBER said he had not the least doubt that many of the shareholders were well satisfied with the dividend which it was proposed to declare, equal to 10 per cent. per annum; but personally—and he had no doubt that many other shareholders had the same opinion—he was not satisfied to accept it. He had purchased his shares, unfortunately, when they were at a very high premium, and the suggested dividend to him meant only 4 per cent. A similar dividend had been declared, and on that occasion £9,530 was carried forward, whereas now the amount proposed to be carried forward was £41,200. He considered that this was unfair to those shareholders who were in the same position as he was, for it was not, in his opinion, an adequate return from an apparently fairly-earned balance. He could not see why another 5 per cent. should not be declared, and that would leave over £20,000 to be carried forward. He would, therefore, move:—

"*That a further dividend of 5 per cent. be paid to the shareholders, carrying forward a balance of £20,486.*"

Mr. CORNER seconded the motion.

The SOLICITOR (Mr. Hutchins): That is out of order. The shareholders have no power over the dividend except to sanction that which is proposed by the directors.

Mr. WEBBER: Is that according to the Articles of Association?

The SOLICITOR: Certainly.

Mr. WEBBER: Then, when are these things to be brought forward? You might carry forward £100,000 next time.

Mr. C. WILSON asked whether the reason for carrying forward such a large sum on the present occasion was that it was expected that the money would be required in the business.

The SOLICITOR read Clause 93 of the Articles of Association relating to the declaration of dividends.

Mr. WEBBER said he thought it was a most arbitrary clause.

The CHAIRMAN: I think it only reasonable.

Mr. WEBBER: Some of the Articles of Association require altering. As this clause stands, it means that the Directors might next year carry forward £100,000 and pay no dividend to the shareholders. I consider it most unjust to the shareholders who paid such a high price for their shares as I did.

Mr. BLANKLEY inquired whether the Chairman could give a good reason why they carried forward so much.

Mr. McCRAE asked whether the amendment could not be altered, and take the form of requesting the Directors to divide another 5 per cent.

Mr. WEBBER said he would alter his amendment and make it in the following form:—

"*That this meeting request the Directors to declare an additional dividend of 5 per cent.*"

The CHAIRMAN: The amendment proposed by Mr. Webber would have no avail in any case. The answer to the question asked by Mr. Blankley, as to what reason we can give for carrying forward such an amount, is that as a trading concern we find it most advantageous to be in a position to buy the raw material judiciously in any quantity. I may tell you that that is one of the sources of our profit during the past year—the favourable purchases we have made. The competition in business, in the manufactured articles, is such that we have to be very careful in laying in our stock of raw material. I believe I have answered the only question, and I will now ask you to express your opinion as regards the resolution. Having put the motion in the usual way, and there being five dissentients, he said: There is a large number in favour of it, and I declare the resolution to be carried.

Mr. BANNATYNE: With much pleasure I move:—

"*That Mr. Silver and the Hon. Henry Marsham be and they now are re-elected Directors of the Company.*"

It is unnecessary for me to add anything to commend this resolution to your approval. Mr. Silver is well known, I may say, to all of us. He has been intimately connected with, and has been largely interested in, the Company for many years; and he has occupied the chair for four years. His knowledge of the business, his experience in the affairs of the Company, as well as his general mercantile capacity, amply qualify him to occupy the position of Chairman. Mr. Marsham is comparatively a new Director, if he will allow me to say so, but he has proved himself to the satisfaction of his colleagues. He has been a very valuable addition to the Board since he joined it.

Mr. ABRAHAM SCOTT seconded the resolution, observing that he concurred in every word which had been said by the previous speaker.

The resolution was carried unanimously.

The CHAIRMAN: I desire to thank you in my own name, and in that of my colleague. I assure you that if we can apply ourselves more closely than we have done to the work of the Company, you may depend on our doing so. Our interest in the Company, I may say, is very large. We have not, perhaps, paid £18 per share for our shares; but I think, Mr. Webber, that that is a consideration we can scarcely enter into.

On the motion of Mr. TREBLE, seconded by Mr. CORNER, Mr. J. Weise was re-elected auditor of the Company's accounts for the current year, with a fee of 30 guineas.

Prof. B. PRICE then moved the following resolutions:—

"*This meeting declares and hereby places on record its sense of the great and valuable services rendered to the Company during the recent strike at the Silvertown Works in the firm, prudent, and just action of Mr. Matthew Gray, the managing director, and tenders to him its acknowledgments and thanks for these services. Secondly, the meeting also places on record its grateful appreciation of the services rendered to the Company by the chief manager and the heads of the several departments in the works at Silvertown during the strike; it acknowledges and thanks them for their zeal, their courageous and determined conduct, their command of resources in circumstances of the greatest difficulty, and their successful action in carrying on the works during so severe a crisis; the fidelity of these officers and their devotion to the interests of the Company have the warmest gratitude of this meeting. The meeting also desires to thank the electrical and the clerical staffs for their never-failing exertions in all emergencies during the strike. Thirdly, the meeting also desires to express and to place on record its sympathy with those workmen and workwomen who remained steadfast to their employment during the strike, notwithstanding the severe trials they were subjected to, and it gives its warm thanks to these employés for their patience and their perseverance.*"

The crisis they had passed through in the last six months had been, he took it, very important, and one that affected not only their particular Company, but questions between capital and labour in all parts of England. From the accounts and the report submitted to the shareholders that day they could not regard the position of the Company as being in any way unsatisfactory; but what they had had to go through might have been attended with very unfortunate consequences to many, though so far as the Company were concerned the strike had signally failed. The disasters which the strikers had brought on their families had been very great. The services of Mr. Gray and others justified all that he had said of them in his resolutions, and he might state that the difficulties which that gen-

Digitized by Google

tleman had had to experience were rendered all the greater by the illness and subsequent death of one of his sons.

The CHAIRMAN: I claim to have the privilege of seconding these resolutions. The vote is justly due to all concerned. Think for a moment what would have been the consequences had a failure taken place, what a different appearance we should have presented to-day, and what a different effect would have been produced on those I see around me. He then put the motion, which was carried unanimously.

A vote of thanks to the Chairman brought the meeting to a close.

City of London and Southwark Subway Company.

The eleventh ordinary general meeting of the proprietors of this Company was held yesterday at Winchester House, Old Broad-street, Mr. Charles Grey Mott, presiding.

The SECRETARY (Mr. H. H. M. Smith) having read the notice convening the meeting,

The CHAIRMAN said that it was with mingled feelings of regret and satisfaction that he rose to move the adoption of the report and accounts; with feelings of regret because he had again to meet the proprietors with an unopened line, and with feelings of satisfaction because during the past half-year most excellent progress had been made with the works of the line. They would learn from the report a good deal as to the actual works which had been carried out; but he might specially call their attention to the very important work of driving the tunnels through the wet gravel. That had been carried on uninterruptedly during the whole of the past half-year, with the result that one of the tunnels had been completed, and that the other had only about four or five weeks' work to be done before it would touch the clay on the other side of that wet hollow. Anyone who knew what the difficulty of the work had been—how unexampled almost the nature of it had been—would appreciate the importance of having driven the tunnel so steadily and safely as they had done through most difficult strata and making the two ends meet almost exactly. It was exceedingly creditable to the contractors, to the engineers, and the engineers' staff engaged upon the undertaking. The other tunnel had also progressed perfectly safely so far, and he hoped, as he had said, that in the course of four or five weeks would be completed and into the clay on the other side. They had also during the past half-year completed the boiler houses at Stockwell, upon the erection of which great care had been bestowed. These were fitted upon what was known as Livet's principle, which was extremely economical in its working and free from giving annoyance to the surrounding neighbourhood by the emission of smoke. There were in all six boilers, and they were now at work, and there was practically no smoke arising from them. He thought they were to be congratulated on that arrangement, because the boilers were situated in a residential neighbourhood to which a large emission of smoke would be a great nuisance. The engine-house at the same depot was also rapidly approaching completion, and they were now preparing to fix the engines and dynamos in it. The necessary engines and arrangements for working the hydraulic machinery—which, as they knew, were very extensive, there being two large lifts at six stations to be provided for—were being completed. There were also arrangements for the electric light stations and carriages to be carried out. Then they had another piece of tunnel which had been a somewhat difficult work to carry out—that was the inclined road from the Stockwell depôt down to the tunnel, along which the whole of the plant and working stock of the railway will be taken up and down. He was happy to say that that was now almost finished. The fixing of the lifts had now fairly commenced at several of the stations. Of course a great deal of work had to be performed in the preparation of the shafts which were now completed and ready for the lifts. One important consideration for them was the question of the electric power to be used for working the line. To a large extent the nature of their undertaking was entirely new, and the contractors had, to some extent, to feel their way. They had had an experimental electric locomotive and carriages down in the tunnel running between King William-street and Great Dover-street, which was the most difficult part of the line to work because it went under the river. There were inclines, and a sharp curve going into King William-street Station, and it was desirable that experiments should be made on that part of the line. Those experiments had been carried on for six months, with the result that great improvements had been made in the locomotive working the train. A second one was tried yesterday, and he could only say from his own personal experience that it worked most admirably. The result would be that the locomotives would be constructed in every way fitted, he believed, to do the work thoroughly and efficiently. The locomotives were now being built, and would be completed in time for the opening of the line. They would have noticed that the effect of the near completion of their railway had been such as to satisfy many engineers and others of the value of the system which they had adopted, with that some five new companies gave Parliamentary notice for this Session that they were to apply to obtain powers to construct similar lines in different parts of the metropolis. Of those, he believed, for financial reasons, only one, or possibly two, were left. The one that he knew was left was very important. It proposed to run a line from Queen's-road, Bayswater, down Oxford-street, New Oxford-street, High Holborn, Newgate-street, Cheapside, to the Bank, and there to erect a great central station, and thence to run to a junction with our line just after it left King William-street Station. If that Bill were passed—and there seemed to be very little reason to suppose that it would not be, because there could be no practical objection to a line of that description—it would of course be naturally a great feeder to this Company's line. The only difficulty that they had experienced was that the proposed junction was not made at a station, and was made in an unsatisfactory way. But they hoped that some negotiations would take place the result of which would be that a junction could be effected satisfactorily to all concerned. He mentioned this only to show how completely those who were watching the progress of the Company's undertaking were satisfied that it was one which would be of great importance to the metropolis in the future. They knew that the Company had got a peculiar name which did not at all express what their undertaking was intended to be. Parliament, the Board of Trade, and the Stock Exchange had ranked them a railway company, and, therefore, it was thought better to assume that name, and no longer retain one which did not convey the meaning intended. They asked the proprietors on that account to change the title of the Company to the City and South of London Railway. The proposed junction with the Oxford-street line might possibly render it necessary to construct a station close by the terminus of the Brighton and South-Eastern Railway Companies, and they took powers to get the necessary land should they wish to carry it out. They would, however, hear more on the subject when the necessity arose. As regarded the accounts, they spoke pretty clearly as to what had been done in the matter of expenditure in the past half-year. They had power to issue a further sum of £50,000 of Debentures, making £150,000 in all, and of these there were about £30,000, or a little over, not yet taken up, and the Directors were issuing them, as was well known, and he thought very wisely, as terminable Debentures for five years, and they had, under the circumstances, to pay a little extra rate; but they thought this course to be much better than to issue them as permanent Debenture Stock at a high rate. For the time being, as the line was unopened, it was thought better to offer 5 per cent. for terminable Debentures, and so far they had been successful in placing £116,000. They would be glad if any of the shareholders would avail themselves of the rest at that very good rate for five years. As to the date when the line would be completed and opened, he had as much as possible avoided fixing it, because everything they had had to do was new, as well as the appliances connected with the undertaking, and it was extremely difficult to say under such circumstances at what time the contractors would get their work finished. But he hoped that some time before they met again the line would be opened for traffic—possibly in July or August.

Mr. WALTER ROBINSON seconded the motion.

Mr. RENDALL wished to ask whether the supports in the tunnel had been ascertained to be sufficient, and what were the terms on which they stood in relation to the contractor as to the security of the tunnel.

The CHAIRMAN said that Mr. Rendall might make himself perfectly easy on the subject of the supports of the tunnel. The gravel was strong and hard, although full of water. The tunnel itself was surrounded outside by a lining of concrete, and any one who knew the support derived from wet sandy gravel would know that the pressure was perfectly even all round, and that it was as solid and good a foundation as they could have. A great many most important buildings were erected upon a similar foundation. There was not the slightest risk or danger to be apprehended in regard to the completion of the second tunnel. It was merely a matter of time. It was going on in a perfectly safe manner. As regarded the contractors' liability, it was the ordinary liability of maintenance for twelve months after the completion of the work.

The resolution was carried unanimously.

On the motion of the CHAIRMAN, seconded by Mr. ROBINSON, the retiring directors were re-elected, as were also the Auditors, Messrs. Turquand Youngs and Co., on the motion of Mr. HART, seconded by Mr. PECK.

The meeting was then made special, when the Company's Bill in Parliament received the sanction and approval of the proprietors.

A vote of thanks to the Chairman terminated the proceedings.

Chelsea Electricity Supply Company (Limited).

The ordinary annual general meeting of this Company was held on Wednesday at the Central Station, Draycott-place, Sloane-square, Mr. John Irving Courtenay (the Deputy-Chairman) presiding.

The SECRETARY (Mr. S. J. Cluer) read the notice convening the meeting, and the report was taken as read.

The CHAIRMAN: Gentlemen, it is my duty, in the absence of Lord Thurlow, to address some observations to you before I move the adoption of the Directors' report and balance-sheet. You are aware that though the Company was registered some time ago, the present Board of Directors was not constituted, nor was the capital obtained for the construction of the works, until after the passing of the Electric Lighting Act of 1888; but it was necessary to include in the balance-sheet such small outlays as were made by our predecessors in office. The Board of Trade inquiry necessitated a heavy expenditure which was absolutely necessary to incur to defend our position, and again we had to take part in the proceedings before the Committees of the two Houses. The figures are fully given, not only in respect of these matters, but of every detail connected with the capital and working account in our balance-sheet and profit and loss account, and I do not purpose to detain you by a recapitulation of them, but I am prepared to answer any questions upon them, and to give any shareholder such further information as he may require. The whole of the work has been carried out by the Brush Electrical Engineering Company, the Callender's Bitumen Telegraph and Waterproof Company, the Electrical Power Storage Company, and the Electric Construction Corporation. Our central station has been open for the supply of electricity since the second week in April last year, when current was first turned on from the 2,000-light storage battery sub-station at Clabon Mews. Since then the increasing demand for electric light has induced the Directors to open two other similar battery sub-stations in different districts, and the plant for a fourth is in course of erection. We began with eight houses in April. During the summer, as a matter of course, the increase was slow. By the end of September we were supplying 41 houses, or 2,990 lights. By December 31st the number had increased to 93 houses, or 8,730 lights, and

Digitized by Google

we now have on our books 134 houses, or over 10,000 lights. I would point out that one of the advantages of the system is, that it lends itself readily to gradual increase of plant, according to the necessarily gradual increase in the demand, and does not necessitate at starting the large expenditure of capital on buildings and heavy machinery in the first onset, as with direct-running systems, in which a long time may elapse before sufficient work can be found to fully employ the plant. All the electricity which has been produced has been supplied to the consumer direct from the E.P.S storage batteries. The consumer is never under any circumstances in connection with the charging current, and therefore he is not subject to the disagreeable pulsation and inequality in the light often noticeable when it is produced direct from running machinery. Nor is he in any way liable to the inconvenience of sudden total extinction of his light from difficulties or mishaps with boilers, engines, or dynamos. It is an interesting fact that upon the E.P.S. system, when the batteries are being charged, the engines and dynamo-electric machinery are always operating under the conditions of highest efficiency and maximum output. This is proved in practice by the small consumption of coal, which, for every Board of Trade unit actually supplied to the consumer's lamps, has an average of about 11lb. You will be gratified to learn that little or no symptoms of wear are discoverable even on those E.P.S. batteries that have been longest in use, and in no case has a single plate had to be renewed. I wish to call particular attention to this question of depreciation of accumulators, because it is one of the main points urged against their adoption. I have always contended that in practice it would be found that when storage batteries were installed in central stations (where one man can look after several hundred cells with as much ease as he can look after a few in a private installation), better results would be obtained than had almost ever been got before, and experience is now showing this to be a fact. When by the automatic arrangements of Mr. F. King's system the batteries have their proper charge regularly, and are not permitted to be unduly discharged; that is, discharged beyond their capacity—in other words, when the batteries receive ordinary intelligent treatment—their life will be considerably prolonged. I hope after the meeting you will go through the station and examine the cells yourselves. The batteries in this station are all in glass cells, and you can therefore judge for yourselves what excellent condition they are all in, but a still stronger answer is found in the fact that the manufacturers are prepared to supply all the necessary material for the renewal of any plates or portion of the battery that require renewing, at the annual rate of 12 per cent.; but here at Chelsea, where we have engineers who are well acquainted with E.P.S. storage batteries, we have declined this offer of the manufacturers, because we prefer to be our insurers, as we know it will cost us less than that. You will observe the remarkable comparative statement in the report for the first complete quarter ending December 31st, from which it will be seen that in the month of October, for coal, water, wages, &c., the expenditure was £82. 0s. 10d., while the "current" invoiced to customers amounted to £146. 1s. 6d.; for November the cost for the same items was £114. 14s., and the amount invoiced £262. 8s. 2d.; for December the cost was £141. 9s. 6d., and the amount invoiced £405. 12s.; that is, in November for an expenditure of 39 per cent. greater than that in October, the increase in revenue is 79½ per cent. more than in October, or double the increase in expenditure; and in December, for an expenditure of 23¾ per cent. more than in November, the increase in revenue is 54¾ per cent. greater than in November, or considerably more than double the increase in expenditure. We have found, in actual practice, that the cost of producing a Board of Trade unit of electricity was, in October, 4¼d.; in November, 3⅜d.; in December, 2⅜d., and this should be further improved when our system of underground conductors is quite complete. I venture to say that no other company nor any other system now being operated in this country could show similar results, and if there is any such, at any rate I am not aware of it, and I shall wait with interest to learn whether any similar equally satisfactory results have been produced elsewhere. The success which has attended the working of the E.P.S. system at Chelsea is making some of the advocates of other systems rather unhappy: they are greatly exercised in their minds, and have rushed into public meetings and into print; and if the statements attributed to them in the press are a correct version of what they are saying, they certainly show an amazing hardihood of statement in connection with storage batteries. Storage batteries now can be relied on, and can be guaranteed to give 70 per cent. on an average, in practical working on a commercial scale, of the amount of electricity put into the battery, and they ordinarily give more; and I am informed by those who have made a close study of the subject, that the alternating-current system with transformers working over the whole 24 hours will have an average efficiency of not more than half the average efficiency of the storage battery system. I am, of course, fully aware that those who are interested in rival systems, argue that the great drawback to the storage system is the initial cost. But I maintain, the difference in favour of other systems (if any) will disappear if an adequate duplication of apparatus, plant, and buildings is provided. Should even the original cost of the plant for the storage system be a little greater, surely it is better in the first onset to put down apparatus that will give the highly efficient results that I have shown, than to adopt other systems that are less reliable and have higher working expenses, such as is necessitated by the absence in those systems of a storage reserve, and when they have got this reserve plant they are still liable to breakdowns of moving machinery. In other words, I say that the customers of the Chelsea Company are supplied with a better article than can be given by any other system, and at the same price, and there can be no question that the public are beginning to appreciate this. I have felt bound to make these observations in consequence of the public attacks that have been made upon our storage battery system. You will be gratified to learn that though the vestry of the important parish of St. George, Hanover-square, refused to consent to our application for a Provisional Order in 1888-9, they have now, on our being able to show such good work in Chelsea and Kensington, unanimously consented to allow our application to the Board of Trade for a large portion of their parish, in spite of the fact that two other companies have already been granted powers in the same district. We are vigorously pushing our business in Chelsea and Kensington. What we have to do now is to add on houses, and so increase our customers as rapidly as we possibly can; and I think you will agree that, in view of the good progress we have lately made in this respect, there is every reason to expect a large increase during the current year. I am assured by those who are acquainted with our central station, substations and plant, the solid manner in which they have been constructed and laid down, and the efficient way in which they have been working, that we shall have no difficulty in obtaining, at a moderate rate, the debentures necessary to successfully carry on the prosecution of our extensions; and the increasing ratio of income over expenditure, as already shown, is sufficient evidence that the issue of debentures, by enabling us to extend our mains and use our central station to its full capacity, will prove eventually a great benefit to our shareholders. I beg to move the adoption of the Directors' report and statement of accounts.

Mr. NUGENT DANIELL seconded the motion.

Prof. AYRTON stated that the Chairman had said that the cost of producing a Board of Trade unit of electricity had been in October, November, and December respectively 4¼d., 3⅜d., and 2⅜d. He wished to know whether that was for coal only, or what else it included?

A SHAREHOLDER inquired at what rate they expected to get the debentures taken up.

Major-General WEBBER, C.B., drew attention to a map suspended from the wall, and indicated the nature of the system, which he described as essentially what was called a network system, the advantages of which over any other system he pointed out. By their system it did not matter whether the generating station, as in the case of that station, was exactly in the centre of the area which had to be supplied, nor whether the

PATENT
SILICIUM BRONZE AND SILICIUM COPPER WIRE.
The best for overhead Telephone and Telegraph Lines,
AND ALL ELECTRICAL PURPOSES.
Hard Drawn High Conductivity Copper Wire.
ROLLED AND DRAWN
PHOSPHOR BRONZE.
PHOSPHOR BRONZE
BEARINGS, BUSHES,
AND OTHER PARTS OF
ELECTRICAL MACHINERY.
SOLE PROPRIETORS of the British, Indian and Colonial Patents,
THE PHOSPHOR BRONZE COMPANY (Limited),
87, Sumner Street, Southwark, London, S.E.
WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

Digitized by Google

storing stations and pressure points were exactly in the centre of the area they were meant to supply, because, by the network system, if one point had more work to do than another, it was aided by the other points with which it was connected. This was the provision made for keeping the pressure constant within the limits of variation established by the Board of Trade. If, however, as might happen, the estimates made as to the actual supply likely to be required over any area were exceeded in actual practice, the deficiency could be quickly remedied by replacing short lengths of the existing conductors with conductors of a larger size and greater carrying capacity. Not, however, that they had had any serious difficulty, but it was a point which he desired the shareholders to be aware of, because when they came to examine the system, and saw other systems, they would find variations elsewhere in the pressure of 10 or even 15 per cent., whereas in their own case the variation was never more than 4 per cent. He then alluded to the projected extension, and said that the advantage which they claimed was that all the money laid out had been spent in actual *bona fide* work, and that the money which they would have to lay out—which they must lay out to fulfil their statutory obligations—would be put in actual mains, machinery, and cells, which would, directly they began to work, earn revenue.

The CHAIRMAN, in answer to Prof. AYRTON, said that the cost he had mentioned of producing a Board of Trade unit of electricity included all charges except general charges.

Major-General WEBBER, continuing, pointed out that the general charges were more or less of a fixed nature. The statement just made by the Chairman was an extremely favourable one, and he thought it was rather bold of Mr. Courtenay to put it forward, because, though it was perfectly correct, still he (the speaker) thought it might be a little increased in actual practice.

The CHAIRMAN said that probably there would be some controversy respecting what had been stated at the meeting, but they were perfectly prepared to defend anything they had said.

Major-General WEBBER, in reply to Mr. CALLENDER, stated that the central station at which they had assembled was large enough to contain plant to supply 10 storage stations—that was to say, besides the one in which they were now met, nine outlying stations. By the addition of transformer motors at each of those storage stations, which was under contemplation, and which would be carried out as soon as the maximum demand was approached, they could increase the capacity of each storage station by 50 per cent. They had made estimates which showed that two-fifths of the number of lamps installed in a house were, on the average, in use. He might say that the Draycott-place station had a capacity of supplying 75,000 lamps installed. Speaking of lamps, their unit of lighting, which they thought was essentially one that should be adopted for all domestic purposes, was of 8 to 10 candle-power. With the plant that was now installed and under contract to be installed they could supply from the Draycott-place station 35,500 lamps installed.

The CHAIRMAN put the resolution in the usual manner, and it was carried unanimously. Subsequently he proposed the re-election of Major-General Webber and Mr. Daniell as Directors.

Mr. CUNYNGHAME seconded the motion, and referred to the valuable services which Major-General Webber had rendered to the Company in bringing them with dogged obstinacy and perseverance through all their difficulties. Mr. Daniell was known to him personally, and no doubt to other gentlemen present, and he thought the Company were extremely fortunate in having the services of two such gentlemen.

The resolution was carried unanimously, and subsequently the auditors, Messrs. Cooper Brothers, were re-appointed.

The CHAIRMAN next proposed the following resolution:—

"*That the Directors be, and they are hereby, authorised to borrow a sum not exceeding £50,000, and to secure the same by the issue of Debentures in such form, secured in such manner, and issued to such persons on such terms and at such times as the Directors may deem expedient.*"

They were advised by the solicitor that the resolution was strictly in accordance with the Articles of Association, and that what they required to do they could do simply with the permission of the shareholders. Some shareholders might think that the amount asked for was rather a large sum, and he agreed that £50,000 was a large sum, but they had to take into consideration a great many points in connection with the proposal. He wanted in the first place to obtain the power for the debenture capital once for all, and therefore they asked for powers to obtain £50,000. They had, however, no intention of spending any such sum as that, but they did not want by raising a small sum now to have any difficulty about raising any further debentures they might require, which might be the case if they only raised an amount sufficient for their present requirements. He thought they would issue at once about £12,000, but it was suggested to him that it might be £15,000. They certainly intended to push on in Chelsea and to occupy the ground so as to keep everybody else out. He believed that if in the next two years they spent the amount he had mentioned, with such further sums as might be found necessary for the extensions, the shareholders would all be satisfied. With regard to the question that had been asked as to the rate at which they would get the debentures out, he could only state that they would endeavour to obtain the money as cheaply as possible. He was not able to state exactly what the price would be, and the present was not the moment for obtaining the capital required; but still they hoped that in a short time money would be cheaper, and if they succeeded in issuing debentures from time to time as they saw it was to the advantage of the shareholders, he should say it would be a decided benefit to obtain the additional capital by means of debentures instead of by issuing fresh shares.

Sir GEORGE PRESCOTT, Bart., seconded the motion. He stated that, like Mr. Courtenay, he represented a large amount of share capital in the concern, and they would be extremely cautious and careful in not calling up more money than they might require, and he assured them that it would be expended to the best advantage of the Company.

The CHAIRMAN put the resolution, which was carried unanimously.

A vote of thanks to the Chairman, proposed by Mr. CARR-GOMM, a shareholder, and seconded by Mr. KING, also a shareholder, was carried unanimously, and the proceedings terminated.

NEW COMPANIES REGISTERED.

TRENT GAS ENGINE COMPANY (LIMITED).—This Company was registered on the 6th inst., with a capital of £15,000, in £10 shares, to acquire certain letters patent granted to Richard Simon for inventions or improvements in or connected with gas engines, and to carry on the business of gas engine manufacturers, mechanical engineers, and general merchants, adopting therefor an unregistered agreement expressed to be made with the said Richard Simon. The number of Directors is not to be less than two, nor more than four; qualification, 25 shares. The Company in general meeting will determine remuneration.

P. AND W. MACLELLAN (LIMITED).—This Company has been formed with a capital of £300,000, in 15,000 Six per Cent. Cumulative Preference Shares of £10 each and 15,000 ordinary shares of £10 each, to acquire and carry on as a going concern the well-known business of Messrs. P. and W. Maclellan of the Clutha Works, Glasgow, engineers, iron and steel wagon and bridge builders, iron, steel, metal, and timber merchants.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended February 14th amounted to £4,662.

DIRECT SPANISH TELEGRAPH COMPANY.—Subject to audit, the Directors of this Company have decided to recommend the payment of the dividend at the rate of 10 per cent. on the Preference shares and a dividend at the rate of 6 per cent. (free of income tax) upon the ordinary shares, making 5½ per cent. on the ordinary shares for 1889, against 4½ per cent. in 1888, and to carry forward the sum of £846.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended February 14th, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,549.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The receipts of this Company for the half-month ended February 15th show an increase of £233 as compared with the corresponding period.

THE NON-CONDUCTOR OF ELECTRICITY.

WAREHOUSE.

VULCANISED FIBRE,

PATENTED.

This new material is supplied in two qualities, Flexible and Hard.

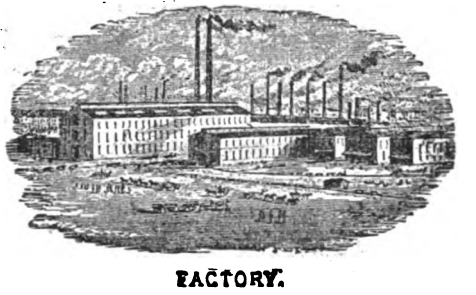
The FLEXIBLE is a substitute for Leather, Rubber, Gutta Percha, &c., and is extensively used by Brass Founders, Axle Makers, Hydraulic, Sanitary, and other Engineers, Pump Makers, Carriage Builders, &c.

It makes the best Hot and Cold Water Packings, and for Axle Washers of all kinds it is unequalled.

The HARD is a substitute for Metals, Hard Wood, Ivory, Vulcanite, Ebonite, &c., and is a good Insulator.

Sold in sheets, 5ft. 6in. by 3ft. 6in., varying in thickness from 1-50in. to 1in.

FLEXIBLE, 2/- per lb.; HARD, 2/3 per lb.


FACTORY.

MOSSES & MITCHELL, 70 Chiswell-st., London, E.C.

Digitized by Google

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Wednesday, Feb. 19, 1890.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending Feb. 19, 1890.	
£			**TELEGRAPHS.**		£ s. d.		Highest.	Lowest.
1,770,360	Stock	12/6	Anglo-American	50 51	5 7 10	Jan., Apr., July, Oct.	50	...
2,614,820	Stock	25/0	Do. Preferred	85 86	6 7 11	,, ,,	86½	85
2,614,820	Stock	...	Do. Deferred	15 15½	...	February	15½	15
130,000	£10	3/0	Brazilian Submarine	12½ 12¾	5 17 8	Mar., June, Oct., Dec.	12⅝	12¼
112,900	£100	5%	Do. 5 per Cent. Bonds	99 101	4 19 0	January and July	...	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	104 107	4 13 6	June and December.	...	...
16,000	10	9/0	Cuba Submarine	11½ 12½	7 4 0	February and August	...	...
6,000	10	10%	Do. Preference 10%	19 20	5 0 0	,, ,,	...	...
12,931	5	2/0	Direct Spanish (£4 paid)	4 4½	4 8 11	March & September	4¼	...
6,000	5	10%	Do. Preference 10%	9 10	5 0 0	April and October	...	...
60,710	20	3/6	Direct United States	10 10¼	6 16 7	Jan., Apr., July, Oct.	10¼	10¼
280,000	10	2/6	Eastern	13⅞ 14⅛	4 12 0	,, ,,	15	13⅛
70,000	10	6%	Do. 6 per Cent. Preference	14⅞ 15⅛	3 18 8	,, ,,	15⅛	14⅞
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock	105 107	3 14 9	May and November.	107	106
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	106 109	4 11 9	February & August	...	...
250,000	10	2/6	Eastern Extension	13⅜ 14	4 12 10	Jan., Apr., July, Oct.	14	13⅜
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	100 102	5 17 8	February & August	100¼	...
473,000	100	5%	Do. 5 per Ct. (Austrln. Gov. Sub.) Debs. 1900	102 105	4 15 3	January and July	...	...
179,177	10	1/9	Globe Telegraph and Trust	8⅝ 8¾	5 15 6	Jan., Apr., July, Oct.	8¾	8⅝
178,992	10	6%	Do. 6 per Cent. Preference	14⅜ 14⅝	4 2 1	,, ,,	14¾	14⅜
150,000	10	5/0	Great Northern	15¼ 15⅜	4 15 3	Jan., July, and April	15⅜	...
17,000	25	12/6	Indo-European	41 43	5 16 3	April and October	42	...
9,000	8	4/0	Reuter's	7 7⅛	5 6 5	April and October	7⅜	...
15,609	10	3/6	West African Telegraph	9⅛ 10⅛	...	...	...	...
300,000	100	5%	Do. 5 per Cent. Debentures	99 102	4 18 0	March & September	101⅛	...
30,000	10	5/0	West Coast of America	10½ 11	4 10 11	January and July	...	...
150,000	100	8%	Do. Debentures 8%	119 124	6 9 1	June and December	120	...
88,321	10	nil.	West India and Panama	3⅜ 3⅞	...	...	3⅞	3⅝
84,563	10	12/0	Do. 1st Preference 6%	11¾ 12¼	...	April and October	12⅛	11¾
4,669	10	10/0	Do. 6 per Cent. 2nd Preference	15 16	3 15 0	...	...	...
45,181	15	6/0	Western Brazilian	10½ 10⅝	6 19 10	May & November	10⅝	10⅜
$1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	118 122	5 14 9	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	102 104	5 15 5	March & September	...	...
			TELEPHONES.					
234,850	14/0	5%	Consolidated Telephone and Maintenance	⅜ ⅝	...	Yearly	...	...
220,000	£1	3%	Oriental (11s. paid)	⅜ ⅝	3 5 11	...	...	...
80,000	5	6%	National	5⅛ 5⅜	...	June and December.	5⅜	5⅜
55,000	5	3/0	United River Plate	4⅞ 5¼	...	January and July	5⅜	4⅞
			ELECTRIC LIGHT.					
500,000	10	...	Metropolitan Electric Supply (£5 paid)	4½ 4⅝	...	...	4⅝	...
79,934	5	6%	Swan United (£3. 10s. paid)	5 5⅛	3 16 5	...	5⅛	5¼
			MISCELLANEOUS.					
87,350	12	12/0	Telegraph Construction and Maintenance	45 47	5 2 3	March and July	46½	...
41,600	10	10/0	India Rubber, Gutta Percha & Telegraph Works	18½ 19½	5 2 7	February & August	19	18½

JABLOCHKOFF'S
DISTRIBUTION PATENT

(Being a Patent for "Producing and Dividing Electric Light," No. 1996 of 1877.)

THE UNITED ELECTRICAL ENGINEERING COMPANY (LIMITED)

Are Proprietors of the above Patent, and Warn the Public against Infringement.

The following are Licensees:—

Anglo-American Brush Electric Light Corporation, Limited.
Crompton & Co., Limited.
S. Z. de Ferranti.—London Electric Supply Corporation, Limited.
W. T. Goolden & Co.
Hammond & Co.
Wilson Hartnell.
Johnson & Phillips.
Laurence, Paris & Scott, Limited.
Nalder Brothers & Co.
Paterson & Cooper.
Ernest Scott & Co.
Siemens Brothers & Co., Limited.
J. G. Statter & Co., Limited.

3, Prince's Mansions, Victoria Street, Westminster.

MANVILLE & MADGEN, *Managing Directors*

Digitized by Google

THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 615.—Vol. XXIV. FRIDAY, FEBRUARY 28, 1890. Price Fourpence.

NOTES.

The exhaustive and highly practical Paper read before the Institution of Electrical Engineers by Mr. Esson will be welcomed as a very valuable addition to electrical literature. The empirical rules, founded on experience, which are given for calculating the possible armature load, and the rise of temperature of the dynamo, will be readily used by engineers whose business it is to get at results without stopping to discuss the scientific justification for the method employed. The values of the leakage coefficients of various kinds of dynamos given in Table I. are of much interest, and it is desirable that these results should be confirmed and supplemented by the work of other experimenters. Among the other important points alluded to in the Paper was the pressure on the bearings of dynamos caused by want of magnetic symmetry in the field in which the armature revolves. This pressure was in one case found to be as high as 1,500 pounds The many devices proposed by the author for obtaining magnetic symmetry deserve attentive study.

According to Mr. Esson, the only cause of divergence from perfect reversibility of the dynamo and motor is the influence of the currents in the coils short-circuited by the brushes. These currents increase the field in the motor and diminish it in the dynamo. The number of coils short-circuited by the brushes is, however, small, and the difference between the E.M.F. of the same machine run both as a dynamo and motor is in some cases so large that this explanation is not satisfactory. The difference obtained by Mr. Esson in some of his experiments, shown in Table IV., amounts to as much as 13 per cent. Part of this difference could be accounted for by self-induction, which indirectly causes energy to be absorbed in the short-circuited coils, but the greater part of it would still remain unaccounted for.

A direct system of electric traction which avoids the use of either a conduit or an overhead conductor is certainly a desideratum. Whether Mr. Frank Wynne's plan, a description of which will be found in another column, has solved this problem, experience alone can show; but the first practical application of a system in which contacts (some 590 to the mile), brought into play by electro-magnets, play so prominent a part will be watched with considerable interest by electrical engineers. A somewhat similar system, due to a Mr. Wheless, of Washington, and adapted to series working, was described in these columns some three months ago (*The Electrician*, November 29, 1889). A method of connecting the sections of the central rail successively with the main insulated conductor has also, we believe, been patented by Ayrton and Perry.

In our correspondence column this week attention has been recalled to the interdependence between the life and efficiency of glow-lamps. Several statements made lately about the efficiencies of certain lamps are quite rightly stigmatised as misleading and useless unaccompanied by any reference to the cost of lamp renewals. Our correspondent proposes that the life of lamps should be compared at a standard efficiency, and suggests 3½ watts per candle-power as being suitable. Data connecting the life with the efficiency of glow-lamps are certainly much to be desired. It would not, however, be fair to compare all lamps under the condition of constant efficiency. The working expenses are composed of the cost of the electrical power, together with that of lamp renewals, and the sum is not a minimum for all lamps at the same electrical efficiency.

It will be seen from our American letter this week that the States Postmaster-General is renewing his efforts to bring about at least a partial transfer of the telegraphs to the control of the Government. That the scheme is only of a limited character will probably lessen the support it might otherwise receive, and would not increase its popularity even if accepted. Notwithstanding that the tendency in the United States is towards State, or municipal, control for all public services, the acquisition of the telegraphs is a project of such magnitude that at present we can hardly regard it as within the sphere of practical politics.

The lighting of American towns by electricity under the auspices of the municipal authorities is a much simpler affair, and it will not surprise us if some of the larger cities soon take possession of the local electric lighting companies' works. The friends of the independent companies argue, of course, that the cost of management will be greater, because everybody employed by Government or municipal bodies in America expects to be paid more than he would get in any other service. But this is the very reason why everybody will support the proposal; for in the States, as in the Emerald Isle, from which they are largely recruited, the pet ambition seems to be to become an "official"—that is to say, a person whose duties are lighter, whose wages are higher, and whose self-importance is greater, than those of people whose living depends on their own exertions.

Digitized by Google

M. BORGMANN describes in a recent number of the *Comptes Rendus* a research on the mechanical action of variable currents, which forms an interesting extension of the experiments of ELIHU THOMSON. Lycopodium powder was spread over the surface of a thin layer of mercury lying in a trough placed above a solenoid, through which an intermittent or alternating current was passed. The frequency used was about 300 per second. The powder was found to be set in motion so as to show the existence of two circular mercury currents flowing in opposite directions, and uniting so as to form a diametral current. The effect was improved by making the layer of mercury as thin as possible. Alternating currents gave better results than intermittent ones, and the presence of an iron core within the solenoid much increased the disturbances. It was not found necessary for the mercury layer to entirely cover the top of the solenoid, as the mercury currents could be observed in isolated drops. By placing pieces of metal over the solenoid the mercury currents were changed, and very curious results were obtained by using a ring formed of three equal sectors of copper, brass and zinc. These interesting experiments are capable of a great deal of extension, and we are glad to see that M. BORGMANN is continuing the research.

DR. LODGE in the current number of *Nature* describes a simple lecture experiment to demonstrate electric resonance. The oscillator consists of a Leyden jar whose inner and outer coatings are connected by means of a rather large loop of wire to two knobs placed near together so as to form a spark gap. The resonator consists of a similar jar whose coatings are connected by a loop of about the same dimensions, but the resistance of which may be adjusted by sliding a copper piece along two parallel wires connected up in circuit. An overflow path is provided for the second jar by means of a strip of tinfoil pasted over its lip and almost long enough to connect the two coatings. By adjusting the position of the slider, the second jar responds every time the first discharges. Prof. LODGE finds that it is not necessary to use long sparks for these experiments, and that, in fact, the vibrations are steadier and more definite with short ones. The extreme simplicity of this experiment will no doubt tempt many to repeat it.

REFERRING to the culvert used by the Pall Mall and St. James's Company, and described by Mr. ADDENBROOKE in our issue of the 14th inst., Mr. ANDERSEN, the patentee, has since pointed out one or two discrepancies, which we correct with pleasure. In the sketches the culvert was drawn with an external flange, which should, however, have been internal. The side of the culvert projects above this internal flange, and the cover fits on it, leaving a space between it and the projection, which is packed with yarn and red and white lead. The external flange is only on the coupling box, which joins two sections together. This coupling box has a projection along its centre, against which the beaded ends of the sections butt, leaving a space which is run with lead, as was described.

WE referred in our issue of January 31st to some important Westinghouse transformer tests, said to have been undertaken at the Massachusetts Institute of Technology, by Mr. W. MARSHALL, under the direction of Prof. C. R. CROSS. Prof. CROSS now writes us that Mr. MARSHALL is entirely unknown to him even by name, and that a student's note-book must have been surreptitiously obtained by him and the figures published. The results given in Mr. MARSHALL'S article form only a small portion of those which have been obtained, converters of various makers having been experimented upon. These tests were, it seems, entirely the work of the students of the Institute, subject only to the general supervision of their instructors, and although Prof. CROSS in no way doubts the substantial accuracy of the figures arrived at, he is not responsible for them. This explanation makes intelligible the omission of all figures relating to efficiency at light-loads to which we called attention at the time.

Tunstall.—The Local Board has decided to support the Order of the Electric Trust Company.

Central London Railway Bill.—This Bill was read a second time in the House of Commons on Tuesday.

International Telegraph Bureau.—M. Frei, Director of Swiss Telegraphs, has been elected Director of the International Telegraph Bureau.

The World's Fair of 1892.—The United States House of Representatives has decided by 157 votes to 107 to make Chicago the scene of the World's Fair in 1892.

Proposed Cable between Tarifa and Ceuta.—The Queen of Spain has signed a decree authorising the Government to present to the Cortes a Bill for laying a cable between Tarifa and Ceuta.

Birmingham Exhibition Awards.—Messrs. Shippey Brothers have been awarded the silver medal diploma for the electric motors exhibited by them at the recent Birmingham Electrical Exhibition.

Croydon.—The Croydon County Council, not having been able to arrange satisfactory terms of purchase with the Croydon Electric Supply Company, have decided to oppose that Company's Order.

Derry.—On Friday last the Derry Corporation held a special meeting to consider their position in relation to electric lighting. It was decided by a majority of 10 to 2 that the Corporation itself should apply for a Provisional Order.

Barnsley.—At the last meeting of the Town Council the Park and Lighting Committee reported that they had approved the conditions of form of proposal to be entered into by companies seeking to supply electricity in the borough.

Maritzburg.—An electric lighting scheme has for some time past caused considerable discussion in this city. The promoters of the scheme wish to be allowed to charge a maximum of 2s. 6d. per unit, about three times the cost of lighting by oil lamps.

Cologne.—The *Elektrotechnisches Echo* announces that the town of Cologne has definitely decided to use alternating currents. The price for private consumers is fixed at ½d. per lamp hour, 500 hours per annum forming the basis of the minimum charge.

The National Electric Light Association Convention.—During the recent meeting of the National Electric Light Association at Kansas City, our enterprising contemporary the *Electrical World* of New York issued a bulletin of the proceedings from its Convention headquarters at Casino Hall, Kansas City.

Appointment Vacant.—The City of London and Southwark Subway Company are prepared to receive applications for the post of general manager of their railway, which will be worked by electric power. Salary to commence at £500 per annum. Applications must be addressed to the Secretary, at the offices, 46, King William-street, not later than Monday, March 10th.

Digitized by Google

A Correction—Problems in the Physics of an Electric Lamp.—On page 394 of our last issue the four lines occurring near Fig. 3 of Dr. Fleming's interesting paper should read:—"We shall illuminate the lamp by a continuous current of electricity, and for brevity's sake speak of that half of the loop of carbon on the side by which the current enters it as the *positive* leg, and the other half of the leg as the *negative* leg," and not as printed.

Rope Gearing.—After having had a certain degree of vogue, says the *Bulletin International de l'Electricité*, rope gearing seems likely to be abandoned, and a return to the discarded belt probable, the reason being that the ropes soon unravel. Although the material is kept in excellent condition at the Halles, the ropes there have already begun to unravel, while the Scellos belts driving the continuous-current machines are still in perfect condition.

Wimbledon.—At the meeting of the Local Board last week, the Electric Lighting Committee laid Mr. Preece's report before the Board. It is proposed to adopt the alternate-current transformer system, and to erect a central station and lay down supply mains at a total cost of £30,000. It is estimated that 350 32 candle-power lamps will replace the 500 oil lamps at present in use. The matter will be further considered at the next meeting of the Board.

Eastern Extension, Australasia, and China Telegraph Company (Limited).—Notice is given that, in pursuance of the conditions upon which the issue of the Five per Cent. Debentures (1880) was made, the sixth and final drawing for payment of these debentures—125 in number—will take place in the presence of a Notary Public, on Monday, March 10th, at 11:30 a.m., at the offices of the company, Winchester House, 50, Old Broad-street, E.C.

Electric Light at Sao Paulo, Brazil.—Rio advices of February 3rd state that the new electric light company of São Paulo has presented a proposal to the Governor for the public and private lighting of that city, assuming the contract with the gas company to be at an end. The prices asked are 15 reis per hour for a 10-candle power incandescent street lamp and 500 reis (about 1s.) per hour for a 500-candle power arc light. Private lighting will be charged 25 per cent. additional.

Institution of Electrical Engineers.—The students of the Institution met last Friday at The Sanctuary, Mr. W. M. Mordey in the chair. A discussion was held on Mr. Swinburne's Paper on the "Theory of Armature Reactions in Dynamos and Motors," in which the Chairman, Messrs. Barton, Walker, Horn, Muir, Childs, and Müller took part. A vote of thanks to the Chairman terminated the proceedings. At the next students' meeting, to be held March 7th, Mr. H. Walker will read a Paper on "Ship Lighting."

Postal Telegraph Balance-Sheet.—A Parliamentary Paper issued yesterday gives an account of the amount received and expended on account of the telegraph service for year ended March 31st last. The gross amount received by the Post Office in respect of telegraphic messages, private wire rentals, special wire rentals, &c., was £2,310,327, the net amount being £2,129,965. The expenditure on account of salaries, rent, and maintenance of telegraphs was £1,969,323, and the balance to meet interest on stock and the redemption of the debt, after paying other expenses, was £88,003. 17s. 9½d.

Reply-Paid Telegrams.—On March 1st, the regulation under which the value of a reply-paid voucher has hitherto been refunded to any person producing the voucher within two months of its date of issue, will be cancelled. In future the value of a reply-paid voucher will only be refunded to the sender of the original telegram, *i.e.*, the person who prepaid the reply. The sender must make application to the Secretary, General Post Office, London, Dublin, or Edinburgh, as the case may be, within two months of the date on which the voucher was issued. The voucher must be produced when the application for the return of the amount is made.

The County Council Testing Station.—At the last meeting of the County Council the Highways Committee reported that they had proceeded further upon the resolution of the Council authorising them to obtain premises suitable for an electric testing station, and they recommended that the Corporate Property Committee be authorised to transfer to the Highways Committee the houses, Nos. 42 and 43, Cranbourn-street, to be used as an electric testing station, and that the Highways Committee be authorised to carry out the works necessary for adapting the premises and to obtain a gas engine and a dynamo for the station at a total estimated cost of about £1,050. This was agreed to.

Undergound Main Systems.—A valued correspondent has supplied the following data omitted from the list published on p. 392 of our last issue:—

Town.	Company and System.	Underground Mains.
Newcastle-on-Tyne	Newcastle and District Electric Lighting Company; alternating, 1,000 volts.	Highest quality of India-rubber (vulcanised) insulation. Cables drawn into cast-iron pipes, with cast-iron junction boxes. All joints vulcanised *in situ* after being made.
„	Newcastle-on-Tyne Electric Supply Company; alternating, 2,000 volts.	Concentric cables drawn into iron pipes, brick junction boxes.

Local Authorities and the Supply of Electricity.—At the last meeting of the Balloon Society of Great Britain Mr. George Offor delivered a lecture on "The Supply of Electricity," referring especially to the action of the local authorities with regard to electrical supply companies seeking Provisional Orders. At the close of the lecture the following resolution was put to the meeting and carried:—"That this meeting urges the Board of Trade to protect the interests of companies prepared to supply electricity from the opposition of local authorities who are unable to prove to the satisfaction of the Board of Trade that their opposition is justified by the special circumstances of the case."

Electric Lighting of the Houses of Parliament.—The first step towards the entire lighting of the Houses of Parliament by electricity was completed, ready for the opening of Parliament on the 11th inst., by the Westminster Electric Supply Corporation. The wiring and fittings inside the building have been carried out from the designs and under the supervision of Mr. Prim, the engineer to the Houses of Parliament, and the effect of the new light, more particularly in St. Stephen's Hall, is most striking.—With reference to a recent paragraph as to the appointment of Mr. Gordon as engineer to this company, we understand that Mr. Gordon has only received the ordinary retainer, and that the chief executive engineer is Prof. Kennedy, F.R.S.

The Electric Light at the Haymarket Stores.—Addressing the shareholders of the Civil Service Co-operative Society at the annual meeting on Monday evening, Mr. Charles J. Cox said that they had found very great advantage from the use of the electric light. It had enabled them to preserve from damage a larger quantity of stock which they would otherwise have been unable to show in the dark winter days, and they proposed at the first available opportunity to extend the electric light throughout the Society's premises. They believed that any extra expense for the light as compared with gas would be more than compensated for by the saving of damage to the stock. At the present time they had not the available space for the machinery, but he wished the shareholders to know that the directors were not losing sight of the great value to the Society of the electric light.

The Inner Temple Installation.—It will be remembered that the large scheme which was started in connection with the Inner Temple, was summarily stopped, and the excavations were filled in. Since then a modified arrangement was prepared with a view to lighting the public offices and supplementing the existing gas engine plant by the addition of a 20 horse-power nominal boiler, and a Willans engine coupled direct to a slow-speed dynamo. The order for this work was given to Messrs. Drake and Gorham, and it has just been completed under the supervision of Mr. W. H. Preece, the consulting engineer to the Inner Temple. The present arrangement allows of any of the three batteries, or all three together, being charged by either dynamo, and the different lamp circuits can be fed from any of the sources of supply. In the summer months the gas engine plant is used for the short runs necessary, or in the event of a sudden fog the gas engine is run until the steam

Digitized by Google

engine is available. This combination of gas and steam will no doubt be found useful in other cases.

Globular Lightning at Pontevedra.—D. Ernesto Caballero, professor of physics, and director of the electric lighting manufactory in Pontevedra, recently wrote to the authorities of the Madrid Observatory giving details of a remarkable meteorological phenomenon which appeared at 9.15 p.m. on January 2nd. In a clear sky there appeared suddenly a ball of fire of the apparent size of an orange, which, after falling upon the conducting wires stretched across the city, entered the manufactory, struck the apparatus for distributing the light, from which (after raising the armature of a magnetic circuit closer) it struck the dynamo at work. It rebounded twice from the dynamo to the conductor, and from the conductor to the dynamo, then fell and burst with a sharp detonation without leaving any trace of its existence. Outside the building, and at the moment of falling upon the conducting wires, the ball was seen by (among others) the Professor of Natural History, Señor Garcéran, and from various effects observed on the wires during the following day there were undoubted manifestations of its electrical origin.

Electrical Bills in Parliament.—The following Bills have been read a second time in the House of Commons:—The Aberdeen Electric Lighting Bill, the Central London Railway Bill, London Subways and Overhead Wires Bill, London Tramways Bill, Luton Gas Bill, and the Partick, Hillhead and Maryhill Gas and Electricity Bill. Petitions have been presented, praying to be heard against the following Bills:—Central London Railway Bill by the Vestries of Paddington, St. George, Hanover-square, and St. Marylebone, the London County Council, the Mercers' Company, the East London Waterworks Company, and Viscount Portman; the City of London and Southwark Subway Bill by the London County Council; the City of London Electric Lighting Bill by the London Electric Supply Corporation and the London County Council; the Partick, Hillhead and Maryhill Gas and Electricity Bill by the Dalmuir, Kilpatrick and Bowling Gas Company, the County Road Board of the lower ward of Lanark, and the Corporation of Glasgow; The London Subways and Overhead Wires Bill by the Kensington and Knightsbridge Electric Lighting Company, the London, Brighton and South Coast Railway Company, and the Southwark and Vauxhall Water Company; The St. Martin's-in-the-Fields Electric Lighting Bill by the London Electric Supply Corporation (Limited) and the London County Council; The Strand Electric Lighting Bill by the London County Council.

Brighton.—In a report issued on Tuesday, the Lighting Committee state that in consequence of a wish expressed by several members of the Council that a second professional opinion should be taken as to the system to be employed by the Council, Mr. R. E. Crompton had been consulted, and his report fully confirmed the opinion of Mr. Shoolbred that the proper system for Brighton is the low tension recommended by the Committee. A site suitable for a generating centre has been offered to the Corporation by Messrs. Vallance and Catt for the sum of £7,000, and the Committee recommend its acceptance. It is further recommended that Mr. J. N. Shoolbred, C.E., should be appointed electrical engineer to the Corporation, "to design, superintend, control, and be responsible for" the whole work. In addition Mr. Shoolbred is to appoint a clerk of the works at a salary of £3 per week (to be paid by the Corporation), who may afterwards, if the Council deem fit, be appointed to take charge as local electrical engineer. The Committee's report concludes with some extracts from Mr. Shoolbred's proposed specifications and Mr. Crompton's report. The plant is to comprise one Babcock and Wilcox and two Galloway boilers; two 120-kilowatt shunt-wound dynamos, running at 350 revolutions, and coupled direct to 200-horse-power compound non-condensing engines; two 45-kilowatt shunt-wound dynamos, running at 450 revolutions, and coupled direct to 80-horse-power engines; a storage battery, in four sets, capable of discharging at the rate of 800 amperes for five hours. A special meeting of the Town Council is convened for Monday next to discuss the report.

The Magnetic Permeability of Soft Steels.—Some dynamo builders having decided to use cast steel for the field-magnet cores and frames of their machines, M. Georges Henrard recently made some experiments at the Montefiore Institute, Liège, in order to find steels sufficiently permeable to be employed for the purpose. The tests, says *La Lumière Electrique*, were made on specimens of steel made at Angleur of all degrees of hardness. The most permeable were very cheap—all could be cast and welded; and No. 6, which cost 7s. 6d. per cwt., was softer than ordinary commercial wrought iron, the carbon contained being only 0·1 to 0·3 per cent. A specimen of wrought iron No. 4, of very good quality, and a specimen of malleable cast-iron from the Herstal foundry, were tested for comparison; the cast iron was a mixture of grey and white pig, and had been decarbonised by heating with Fe_2O_3. The author states that, with **H** equal to 240 C.-G.-S. units, the value of **B** for the bar of malleable iron was more than 15,000 C.-G.-S.; whereas Dr. Hopkinson, in a work published in 1885, gives 12,408 C.-G.-S. as the maximum induction for the metal with the same field. The permeability of a steel cannot be judged of by its percentage of carbon merely, as small percentages of other elements alter the results greatly. For instance, steel No. 5·5, which should be softer and more permeable than No. 5, gave a poorer result, owing to having a greater percentage of manganese. The following table is compiled from some of M. Henrard's figures:—

Steel.	H	μ	Steel.	H	μ
No. 6	250	100	No. 4	250	76
No. 5·5	250	80	No. 3·5	250	80
No. 5	250	80	No. 3	250	74
No. 4·5	250	86	No. 4 (wrought iron)	250	80

Tempered Copper for Electrical Work.—In a recent number of *The Electrical World*, Mr. G. H. Bliss calls attention to the claims of the Eureka Tempered Copper Company, of North East, Pa. The present process of tempering copper has been devised by Mr. Almer Thomas, and its importance is well understood among electricians. Though no table is as yet at hand showing the results of a large number of electrical measurements upon samples of tempered copper, it has been conclusively demonstrated that the modern tempering process does not injure in the slightest degree the conductivity of the copper. By the Thomas process copper is tempered to almost any degree of hardness. Its tensile strength is easily made four or five times that of pure copper, and much superior to hard-drawn copper. Its utility for overhead electrical conductors, where strength and high conductivity must be had, is superior to that of copper in any other form. By this process the Eureka Tempered Copper Company are able to furnish pure copper castings of any desired dimensions. These castings are tempered when required to any degree of hardness. It is a well-known fact that alloyed copper is quickly attacked by alkali, salt water, and mercury. Pure copper is much less affected, and it is therefore practicable to use tempered copper in the form of castings, sheets, and wire in many places where alloyed copper is not available. "Few of us," says Mr. Bliss, "ever supposed that copper would be used for springs, yet this is practicable." The merits of tempered copper have been quickly recognised by many in the electrical fraternity, and already such companies as the Edison, Thomson-Houston, and Westinghouse are using it to a considerable extent. Its superiority over drop-forged castings for commutators and many purposes is readily apparent. Drop forged castings necessarily have greater electrical resistances than pure copper. Pure copper, properly tempered, when used in commutators, is very durable. Tempered copper, when used for gear wheels for electric motors, is noiseless and lasting. It is next to impossible to break or twist off a tooth in a tempered copper gear wheel. "The uses to which tempered copper can be applied," Mr. Bliss remarks in conclusion, "are multiplying daily, and seem to be held in check only by the considerable cost of the article. To those in the electrical profession who have not given the subject attention, it is worthy of early consideration. No one can investigate it without being convinced that its extended use will greatly increase the efficiency, reliability, and durability in every branch of electrical science."

Digitized by Google

MAGNETISM IN IRON AND OTHER METALS.*—VII.

BY PROF. J. A. EWING, F.R.S.

(*Continued from page 391.*)

§ 40. **Magnetometric Method** (*continued*).—Another position for the specimen to be magnetised is shown in Fig. 14. The plane of the sketch is vertical. O is the magnetometer, which, when undeflected, points at right angles to the plane of the paper. The bar is fixed behind it, standing vertically with its upper pole at the level of the magnetometer. The deflecting force F_2 is mainly due to the upper pole: its value is—

$$\frac{\pi a^2 I}{O Q^2} - \left(\frac{\pi a^2 I}{O Q^2}\right)\frac{O Q}{O Q'} = \frac{\pi a^2 I}{O Q^2}\left\{1 - \left(\frac{O Q}{O Q'}\right)^3\right\}$$

And since this is equal to $F_1 \tan\theta$, we have

$$I = \frac{O Q^2 F_1 \tan\theta}{\pi a^2\left\{1 - \left(\frac{O Q}{O Q'}\right)^3\right\}}.$$

This arrangement is particularly applicable where we have to deal with a very long cylindrical rod (diameter $2a$). In such a rod the position of the effective poles Q and Q′ is uncertain, and, indeed, varies when the intensity of magnetisation is varied. But the method has this advantage, that a change in the position of Q along the rod produces very little change in its distance from the magnetometer,

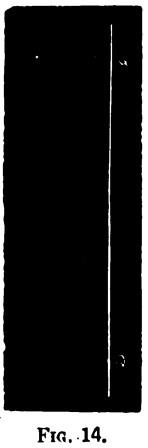


Fig. 14.

and has little effect in altering the deflecting force, while, as to the other pole Q′, its total effect is so small that a movement of it is also without much influence. The best height at which to set the rod will be found by giving it a moderate degree of magnetisation, and finding by trial how high the upper end should stand above the level of the magnetometer to make the deflection a maximum. In this way the position of Q, and therefore of Q′ also, may be found with sufficient accuracy to allow the formula to be applied to a very long cylinder. For brevity, we may distinguish this as the "one-pole" method, seeing that the deflection of the magnetometer is mainly caused by one of the bar's poles.

§ 41. **Details of Magnetometric Method.**—A form of magnetometer, which is exceedingly convenient for observations of this kind, and can be made by anyone at a very trifling cost, is shown in Fig. 15. The suspended "needle" consists of one of the mirrors used in Sir W. Thomson's reflecting galvanometers, with small magnets cemented on the back. The mirror M is hung from a pin, S, at the top of a wooden upright, by a silk fibre three or four inches long. A groove is cut in the upright to allow the fibre to hang free, and at the bottom a round hole, closed in front by a lens, forms a chamber in which the mirror hangs. A glass plate is cemented on the back of the upright to cover the hole and the groove. The upright is fixed to a horizontal plate furnished with three levelling screws. The deflection of the mirror is read in the usual way by means of a lamp and scale.

* All rights are reserved.

In using a mirror magnetometer, the angle through which the needle is deflected may generally be kept so small that no account need be taken of the difference between $\tan\theta$ and θ, and consequently the scale readings may be taken as proportional to the deflecting forces. Thus, if we have a scale 50cm. long, set one metre from the magnetometer, a deflection of the needle amounting to only about 7deg. will make the spot of light travel from the middle to the end of the scale. (It must be remembered that the angular deflection of the mirror is only half that of the beam of light.) Even for this largest deflection the error caused by taking scale divisions instead of tangents is barely a half of one per cent., and for smaller deflections the error is very much less. In such a case, therefore, instead of $\tan\theta$ we may write θ, which is equal to $\frac{\delta}{2D}$, δ being the deflection as measured on the scale, and D the distance of the scale from the mirror expressed in scale divisions.

Fig. 16 illustrates an arrangement for examining the magnetic quality of long thin rods or wires by the "one-pole" variety of the magnetometric method. The specimen is slipped into a tube, A, which is clamped in a vertical position behind the magnetometer B, the distance being adjusted by trial to make the deflection conveniently large. Over the tube a magnetising solenoid is wound, extending a little way above and below the wire core, so that the magnetising force inside may be sensibly uniform, except in so far as it is affected by the ends of the specimen itself. (When only one wire is to be tested, the magnetising solenoid may conveniently enough be wound on the wire itself, instead of on a tube.) Owing to the vertical position of the specimen, it is exposed to the vertical

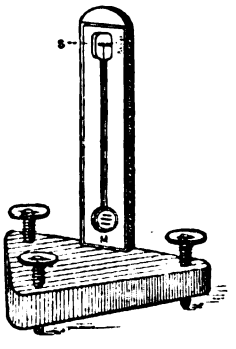


Fig. 15.

component of the earth's magnetic force. For many purposes it is desirable to eliminate this, so that the only force acting along the wire may be that due to the magnetising solenoid. To secure this a second solenoid is wound upon the tube, and through it a constant current is kept up, the strength of which is adjusted (by a method to be described later) until the magnetic force it produces within the tube just balances the earth's vertical force. In the sketch, the single gravity Daniell cell C and the resistance box D give the means of maintaining and regulating this constant current.

In circuit with the main solenoid and behind the specimen is a coil, E, consisting of a few turns of wire wound on a wooden frame which can slide towards or from the magnetometer, its axis passing through the magnetometer at right angles to the undeflected direction of the needle. This "compensating coil," as we shall call it, serves to neutralise the direct action of the magnetising solenoid upon the magnetometer. Its position is adjusted thus: Before putting the specimen to be magnetised into the magnetising solenoid, pass a fairly strong current through the solenoid and the compensating coil, and push the coil backwards or forwards until the magnetometer shows no deflection. The adjustment remains correct for all currents, and its effect is that when the specimen is put in no deduction has to be made from the observed deflection on account of the magnetising solenoid.

We may of course allow for the effect of the solenoid without using a compensating coil, by observing what deflection the solenoid itself produces with a given strength of current when the specimen is removed, and then making a proportional

Digitized by Google

deduction for other currents. The compensating coil, however, has a great advantage over this in point of practical convenience, and has other uses besides, of which examples will be given later.

In each part of the connections the leading wires are twisted together—a very necessary precaution to prevent their acting on the magnetometer.

In examining the permeability of a specimen, a weak magnetising current is first applied, and this is increased step by step or continuously, observations of the current strength being taken along with observations of the magnetometric deflection. A storage battery forms the most convenient source of current; use a low-resistance mirror galvanometer, strongly controlled by a fixed permanent magnet, and test its sensibility by passing a current through it from a gravity Daniell cell; the strength of the current in amperes may be taken as $\frac{1 \cdot 1}{R}$, where R is the total resistance of the circuit in ohms. Care must be taken to set up the galvanometer far enough away from the magnetometer to prevent one from acting on the other.

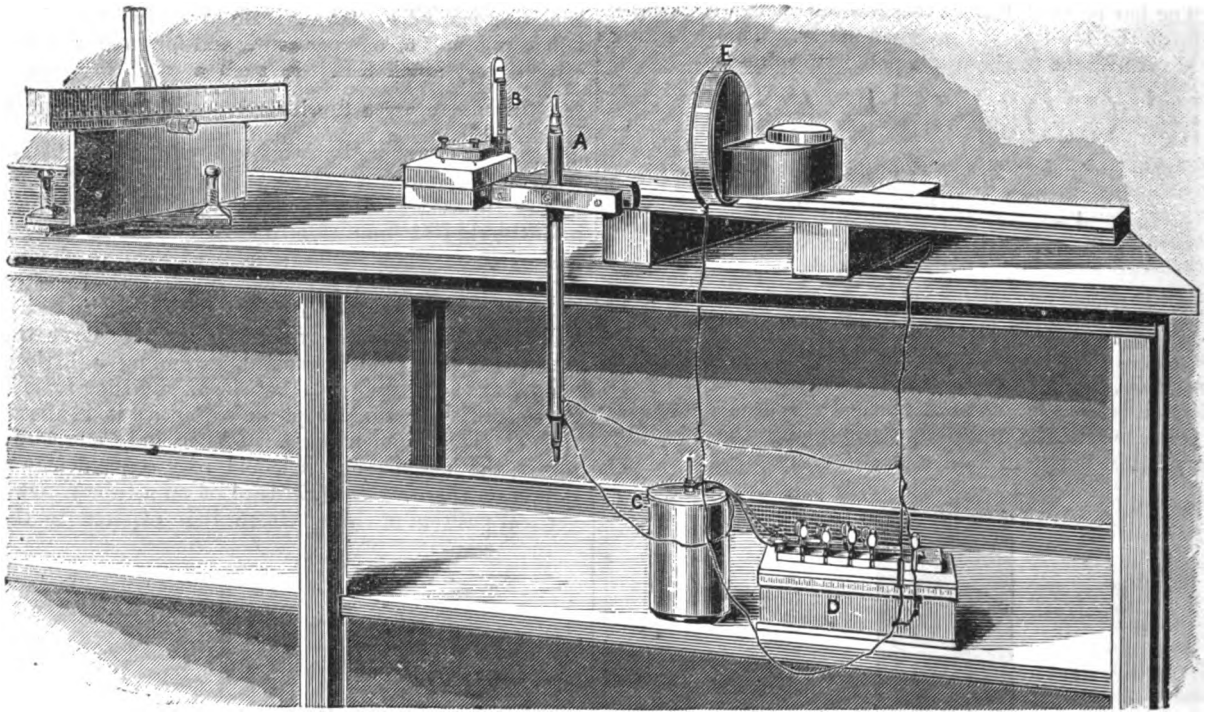


Fig. 16.—Arrangement for Examining the Magnetic Quality of Long Thin Rods.

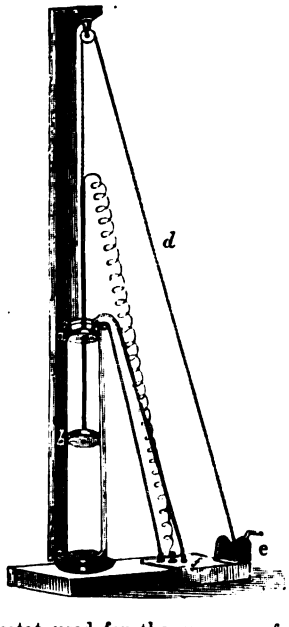


Fig. 17.—Liquid rheostat used for the purpose of continuously altering the strength of the magnetising current.

that is not available, a battery of gravity Daniell's will do well. To observe the current strength, any good form of galvanometer or ampere-meter may be kept in circuit with the magnetising solenoid. A plan which is as good as any is to

In many magnetic experiments it is desirable to have the means of altering the magnetising current continuously instead of by steps, between zero and its highest value. This is conveniently effected by using the liquid rheostat, or potential slide, shown in Fig. 17. A tall glass jar of fairly uniform bore, two inches or so in diameter, is filled with dilute solution of sulphate of zinc. Three blocks of amalgamated zinc, *a*, *b*, and *c*, are fitted in the jar, one lying at the bottom, another fixed at the top, and the third hung between them so that

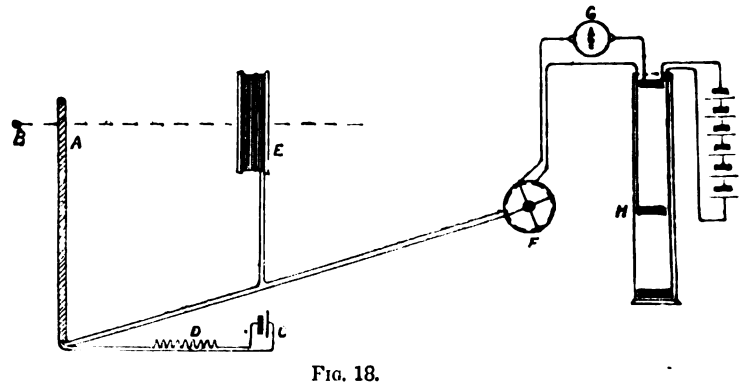


Fig. 18.

it may be raised or lowered by the cord *d* which passes over a pulley above to the little winch at *e*. The blocks are connected to three terminals at *f*, insulated wires being led up through the liquid from the middle and lower blocks. The battery is connected to *a* and *c*, so that the liquid column forms a shunt to it, and a part of its E.M.F. is taken off to produce current in the magnetising solenoid by connecting the ends of the solenoid to one of the fixed and one of the moving blocks, say *a* and *b*. Thus, when *b* is raised into contact with *a* no current passes through the solenoid, and when *b* is

Digitized by Google

gradually lowered the current increases, reaching its highest value when *b* touches *c*. With this slide it is easy to adjust the current to any intermediate value, and to keep it constant for as long as may be wished.

Fig. 18 is a general diagram of the connections. The letters A, B, C, D and E refer to the same parts as in Fig. 16. F is a revolving commutator, G a galvanometer for measuring the magnetising current, and H is the slide described above.

§ 42. **Demagnetising by Reversals.**—The liquid slide gives a handy means of performing a process which is resorted to when we wish to rid the specimen of any initial magnetism it may possess, or to wipe out the residual effects of previous operations. The process of "demagnetising by reversals" consists in applying a numerous series of magnetic forces alternating in direction, and gradually diminishing to zero. A commutator or rapid reversing key is inserted either between the battery and the slide or between the slide and the magnetising solenoid. Working it rapidly with one hand, and turning the winch-handle of Fig. 17 very slowly with the other, the operator applies a long series of alternating magnetising currents, each a very little weaker than the one before it, and the result is, when the process is carefully conducted, to remove all trace of residual magnetism, provided the strongest current of the series is at least as strong as the current by which the piece had been previously magnetised.

§ 43. **Adjustment of the Current Required to Balance the Vertical Component of the Earth's Field.**—The operation of demagnetising by reversals will not be completely successful unless the earth's vertical force is very exactly balanced, otherwise there will be a one-sidedness in the alternate opposite magnetic forces, which will show itself by leaving a persistent residue of magnetism in one direction or the other, the direction depending on whether the constant current which is applied to balance the earth's force is too strong or too weak. This affords an excellent criterion by which we may adjust the current. It has to be strengthened or weakened until, when the process of demagnetising by reversals is performed, the demagnetisation is complete. The more susceptible the material within the solenoid the more sensitive is the test, and it is well to keep at hand, for the purpose of adjusting the current in this way, a core of soft annealed iron, which may be slipped into the solenoid when the test is to be made. In order to increase the sensibility further, when a fine adjustment is required, the solenoid should be set a good deal closer to the magnetometer than it is set when we are afterwards measuring the magnetism of a wire or rod within it.

(To be continued.)

PROBLEMS IN THE PHYSICS OF AN ELECTRIC LAMP.*

BY PROF. J. A. FLEMING, M.A., D.SC., M.R.I.

(Concluded from page 395.)

At this stage it will perhaps be most convenient to outline briefly the beginnings of a theory proposed to reconcile these facts, and leave you to judge how far the subsequent experiments confirm this hypothesis. The theory very briefly is as follows:—From all parts of the incandescent carbon loop, but chiefly from the negative leg, carbon molecules are being projected which carry with them, or are charged with, negative electricity. I will in a few moments make a suggestion to you which may point to a possible hypothesis on the manner in which the molecules acquire this negative charge. Supposing this, however, to be the case, and that the bulb is filled with these negatively-charged molecules, what would be the result of introducing into their midst a conductor such as this middle metal plate which is charged positively? Obviously, they would all be attracted to it and discharge against it. Suppose the positive charge of this conductor to be continually renewed, and the negatively-charged molecules continually supplied, which conditions can be obtained by connecting the middle plate to the positive electrode of the lamp, the obvious result will be to produce a current of electricity flowing through the wire or galvanometer, by means of which this middle plate is connected to the positive electrode of the lamp. If, however, the middle plate is connected to the negative electrode of the lamp, the negatively-charged molecules can give up no charge to it, and produce no current in the interpolated galvanometer. We see that on this assumption the effect must necessarily be diminished by any arrangement which prevents these negatively-charged molecules from being shot off the negative leg or from striking against the middle plate. Another obvious corollary from this theory is that the "Edison effect" should be annihilated if the metal collecting plate is placed at a distance from the negative leg much greater than the mean free path of the molecules.

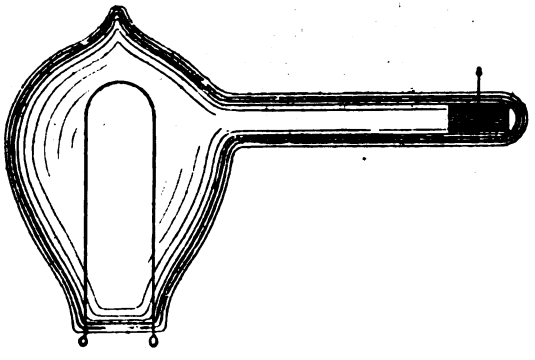


FIG. 8.—Collecting plate placed at end of tube, 18in. in length, opening out of bulb.

Here are some experiments which confirm this deduction. In this bulb (Fig. 8) the metal collecting plate, which is to be connected through the galvanometer with the positive terminal of the lamp, is placed at the end of a long tube opening out of and forming part of the bulb. We find the "Edison effect" is entirely absent, and that the galvanometer current is zero.

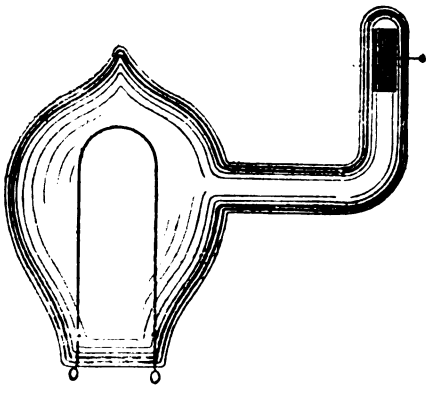


FIG. 9.—Collecting plate placed at end of elbow tube opening out of bulb.

We have, as it were, placed our target at such a distance that the longest range molecular bullets cannot hit it, or, at least, but very very few of them do so. Here again is a lamp in which the plate is placed at the extremity of a tube opening out of the bulb, but bent at right angles (Fig. 9). We find in this case, as first discovered by Mr. Preece, that there is no "Edison effect." Our molecular marksman cannot shoot round a corner. None of the negatively charged molecules can reach the plate, although that plate is placed at a distance not greater than would suffice to produce the effect if the bend were straightened out. Following out our hypothesis into its consequences would lead us to conclude that the material of which the plate is made is without influence on the result, and this is found to be the case. Many of the foregoing facts were established by Mr. Preece as far back as 1885, and I have myself abundantly confirmed his results.

* A discourse delivered at the Royal Institution on Friday evening, February 14, 1890.

Digitized by Google

We should expect also to find that the larger we make our plate, and the nearer we bring it to the negative leg of the carbon, the greater will be the current produced in a circuit connecting this plate to the positive terminal of the lamp. I have before me a lamp with a large plate placed very near the negative leg of the carbon of a lamp, and we find that we can collect enough current from these molecular charges to work a telegraph relay and ring an electric bell. The current which is now working this relay is made up of the charges collected by the plate from the negatively-charged carbon molecules which are projected against it from the negative leg, across the highly perfect vacuum. I have tried experiments with lamps in which the collecting plate is placed in all kinds of positions, and has various forms, some of which are here, and are represented in the diagrams before you; but the result may all be summed up by saying that the greatest effects are produced when the collecting plate is as near as possible to the base of the negative end of the loops, and, as far as possible, encloses, without touching, the carbon conductor. Time will not permit me to make more than a passing reference to the fact that the magnitude of the current flowing through the galvanometer when connected between the middle plate and the positive terminal of the lamp often "jumps" from a low to a high value, or *vice versâ*, in a remarkable manner, and that this sudden change in the current can be produced by bringing strong magnets near the outside of the bulb.

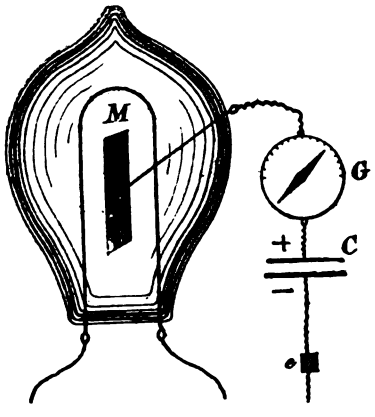


FIG. 10.—Charged condenser *C* discharged by middle plate *M*, when the positively charged side of condenser is in connection with the plate and other side to earth *e*.

Let us now follow out into some other consequences this hypothesis that the interior of the bulb of a glow lamp when in action is populated by flying crowds of carbon atoms all carrying a negative charge of electricity. Suppose we connect our middle collecting plate with some external reservoir of electric energy, such as a Leyden jar, or with a condenser equivalent in capacity to many hundreds of Leyden jars, and let the side of the condenser which is charged positively be first placed in connection through a galvanometer with the middle plate (*see* Fig. 10), whilst the negative side is placed in connection with the earth. Here is a condenser of two microfarads capacity so charged and connected. Note what happens when I complete the circuit and illuminate the lamp by passing the current through its filament. The condenser is at once discharged. If, however, we repeat the same experiment with the sole difference that the negatively charged side of the condenser is in connection with the middle plate then there is no discharge. The experimental results may be regarded from another point of view. In order that the condenser may be discharged as in the first case it is essential that the negatively charged side of the condenser shall be in connection with some part of the circuit of the incandescent carbon loop. This experiment with the condenser discharged by the lamp may be then looked upon as an arrangement in which the plates of a charged condenser are connected respectively to an incandescent carbon loop and to a cool metal plate, both being enclosed in a highly vacuous space, and it appears that when the incandescent conductor is the negative electrode of this arrangement the discharge takes place, but not when the cooler metal plate is the negative electrode of the charged condenser. The negative charge of the condenser can be carried across the vacuous space from the hot carbon to the colder metal plate, but not in the reverse direction.

This experimental result led me to examine the condition of the vacuous space between the middle metal plate and the negative leg of the carbon loop in the case of the lamp employed in our first experiment. Let us return for a moment to that lamp. I join the galvanometer between the middle plate and the negative terminal of the lamp, and find, as before, no indication of a current. The metal plate and the negative terminal of the lamp are at the same electrical potential. In the circuit of the galvanometer we will insert a single galvanic cell having an electromotive force of rather over one volt. In the first place let that cell be so inserted that its negative pole is in connection with the middle plate, and its positive pole in connection through the galvanometer with the negative terminal of the lamp (*see* Fig. 11). Regarding the circuit of that cell alone, we find that it consists of the cell itself, the galvanometer wire, and that half-inch of highly vacuous space between the hot carbon conducter and the middle plate. In that circuit the cell cannot send any sensible current at all, as it is at the present moment connected up. But if we reverse the direction of the cell so that its positive pole is in connection with the middle plate, the galvanometer at once gives indications of a very sensible current. This highly vacuous space, lying between the middle metal plate on

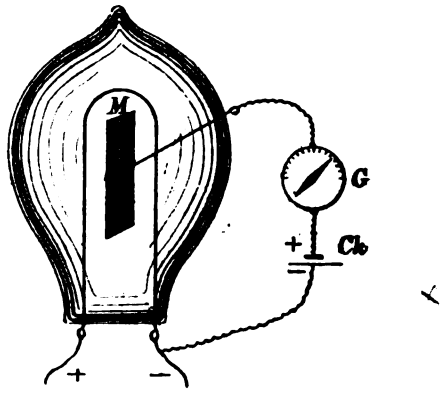


FIG. 11.—Current from Clark cell *Ck* being sent across vacuous space between negative leg of carbon and middle plate *M*. Positive pole of cell in connection with plate *M* through galvanometer *G*.

the one hand and the incandescent carbon on the other, possesses a kind of unilateral conductivity, in that it will allow the current from a single galvanic cell to pass one way but not the other. It is a very old and familiar fact, that in order to send a current from a battery through a highly rarefied gas by means of metal electrodes, the electromotive force of the battery must exceed a certain value. Here, however, we have indication that if the negative electrode by which that current seeks to enter the vacuous space is made incandescent the current will pass at a very much lower electromotive force than if the electrode is not so heated.

A little consideration of the foregoing experiments led to the conclusion that in the original experiment, as devised by Mr. Edison, if we could by any means render the middle plate very hot, we should get a current flowing through a galvanometer when it is connected between the middle plate and the negative electrode of the carbon. This experiment can be tried in the manner now to be shown. Here is a bulb (Fig. 12) having in it two carbon loops; one of these is of ordinary size and will be rendered incandescent by the current from the mains. The other loop is very small, and will be heated by a well-insulated secondary battery. This smaller incandescent loop shall be employed just as if it were a middle metal plate. It is, in fact, simply an incandescent middle conductor. On repeating the typical experiment with this arrangement we find that the galvanometer indicates a current when connected between the middle loop and either the positive *or* the negative terminal of the main carbon. I have little doubt but that if we could render the platinum plate in our first-used lamp incandescent

Digitized by Google

by concentrating on it from outside a powerful beam of radiant heat we should get the same result.

A similar set of results can be arrived at by experiments with a bulb constructed like an ordinary vacuum tube, and having small carbon loops at each end instead of the usual platinum or aluminium wires. Such a tube is now before you (*see* Fig. 13), and will not allow the current from a few cells of a secondary battery to pass through it when the carbon loops are cold. If, however, by means of well insulated secondary batteries we render both of the carbon loop electrodes highly incandescent, a single cell of a battery is sufficient to pass a very considerable current across that vacuous space provided the resistance of the rest of the circuit is not large. We may embrace the foregoing facts by saying that if the electrodes, but especially the negative electrode, which form the means of

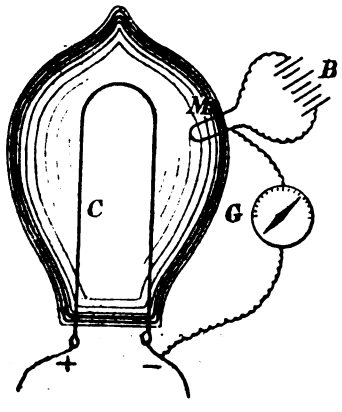


FIG. 12.—Experiment showing that when the "middle plate" is a carbon loop rendered incandescent by insulated battery *B*, a current of negative electricity flows from *M* to the positive leg of main carbon *C* across the vacuum.

ingress and egress of a current into a vacuous space are capable of being rendered highly incandescent, and if at that high temperature they are made to differ in electrical potential by the application of a very small electromotive force, we may get under these circumstances a very sensible current through the rarefied gas. If the electrodes are cold a very much higher electromotive force will be necessary to begin the discharge or current through the space. These facts have been made the subject of elaborate investigation by Hittorf and Goldstein, and more recently by Elster and Geitel. It is to Hittorf that I believe we are indebted for the discovery of the fact that by heating the negative electrode we greatly reduce the apparent resistance of a vacuum.

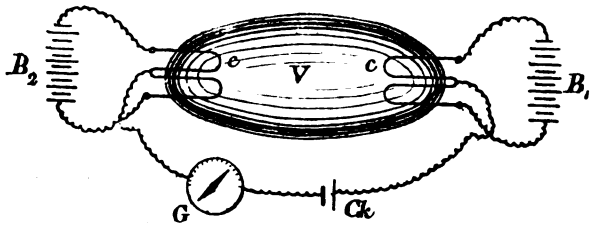


FIG. 13.—Vacuum tube having carbon loop electrodes, *c c*, at each end rendered incandescent by insulated batteries, B_1 B_2, showing current from Clark cell, *Ck*, passing through the high vacuum when the electrodes are incandescent.

Permit me now to pave the way by some other experiments for a little more detailed outline of the manner in which I shall venture to suggest these negative molecular charges are bestowed. This is really the important matter to examine. In seeking for some probable explanation of the manner in which these wandering molecules of carbon in the glow-lamp bulb obtain their negative charges, I fall back for assistance upon some facts discovered by the late Prof. Guthrie. He showed some years ago new experiments on the relative powers of incandescent bodies for retaining positive and negative charges. One of the facts he brought forward* was that a bright red-hot iron ball, well insulated, could be charged negatively, but could not retain for an instant a positive charge. He showed this fact in a way which it is very easy to repeat as a lecture experiment. Here is a gold-leaf electroscope, to which we will impart a positive charge of electricity, and project the image of its divergent leaves on the screen. A poker the tip of which has been made brightly red hot is placed so that its incandescent end is about an inch from the knob of the electroscope. No discharge takes place. Discharging the electroscope with my finger, I give it a small charge of negative electricity, and replace the poker in the same position. The gold leaves instantly collapse. Bear in mind that the extremity of the poker when brought in contiguity to the knob of the charged electroscope becomes charged by induction with a charge of the opposite sign to that of the charge of the electroscope, and you will at once see that this experiment confirms Prof. Guthrie's statement, for the negatively-charged electroscope induces a positive charge on the incandescent iron, and this charge cannot be retained. If the induced charge on the poker is a negative charge it is retained, and hence the positively-charged electroscope is not discharged, but the negatively-charged electroscope at once loses its charge. Pass in imagination from iron balls to carbon molecules. We may ask whether it is a legitimate assumption to suppose the same fact to hold good for them, and that a hot carbon molecule or small carbon mass just detached from an incandescent surface behaves in the same way and has a greater grip for negative than for positive charge? If this can possibly be assumed, we can complete our hypothesis as follows:—Consider a carbon molecule or small congerie of molecules just set free by the high temperature from the negative leg of the incandescent carbon horseshoe. This small carbon mass finds itself in the electrostatic field between the branches of the incandescent carbon conductor (*see* Fig. 14). It

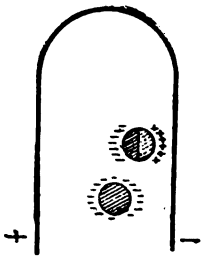


FIG. 14.—Rough diagram illustrating a theory of the manner in which projected carbon molecules may acquire a negative charge.

is acted upon inductively, and if it behaves like the hot iron ball in Prof. Guthrie's experiment it loses its positive charge. The molecule then being charged negatively is repelled along the lines of electric force against the positive leg. The forces moving it are electric forces, and the repetition of this action would cause a torrent of negatively-charged molecules to pour across from the negative to the positive side of the carbon horseshoe. If we place a metal plate in their path, which is in conducting connection with the positive electrode of the lamp carbon, the negatively-charged molecules will discharge themselves against it. A plate so placed may catch more or less of this stream of charged molecules which pour across between the heels of the carbon loop. There are many extraordinary facts, which as yet I have been able only imperfectly to explore, which relate to the sudden changes in the direction of the principal stream of these charged molecules, and to their guidance under the influence of magnetic forces. The above rough sketch of a theory must be taken for no more than it is worth, viz., as a working hypothesis to suggest further experiments.

These experiments with incandescence lamps have prepared the way for me to exhibit to you some curious facts with respect to the electric arc, and which are analogous to those which we have passed in review. If a good electric arc is formed in the usual way, and if a third insulated carbon held at right angles to the other two is placed so that its tip just dips into the arc

* "On a New Relation between Electricity and Heat," *Phil Mag.*, Vo XLV., p. 308. 1873.

Digitized by Google

(*see* Fig. 15), we can show a similar series of experiments. It is rather more under control if we cause the arc to be projected against the third carbon by means of a magnet. I have now formed on the screen an image of the carbon poles and the arc between them in the usual way. Placing a magnet at the back of the arc, I cause the flame of the arc to be deflected laterally and to blow against a third insulated carbon held in it. There are three insulated wires attached respectively to the positive and to the negative carbons of the arc, and to the third or insulated carbon, the end of which dips into the flame of the arc projected by the magnet. On starting the arc this third carbon is instantly brought down to the same electrical potential as the negative carbon of the arc, and if I connect this galvanometer in between the negative carbon and the third or insulated carbon I get, as you see, no indication of a current. Let me, however, change the connections and insert the circuit of my galvanometer in between the positive carbon of the arc and the middle carbon, and we find evidence, by the violent impulse given to the galvanometer that, there is a strong current flowing through it. The direction of this current is equivalent to a flow of negative electricity from the middle carbon through the galvanometer to the positive carbon of the arc, We have here then the "Edison effect" repeated with the electric arc. So strong is the current flowing in a circuit connecting the middle carbon with the positive carbon that I can, as you see, ring an electric bell and light a small incandescent lamp when these electric-current detectors are placed in connection with the positive and middle carbons.

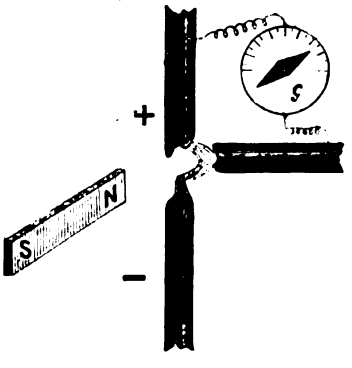


FIG. 15.—Electric arc projected by magnet against a third carbon, and showing strong electric current flowing through a galvanometer, *G*, connected between the positive and third carbon.

We also find that the flame-like projection of the arc between the negative carbon possesses a unilateral conductivity. I join this small secondary battery of fifteen cells in series with the galvanometer, and connect the two between the middle carbon and the negative carbon of the arc. Just as in the analogous experiment with the incandescent lamp, we find we can send negative electricity along the flame of the arc one way but not the other. The secondary battery causes the galvanometer to indicate a current flowing through it when its negative pole is in connection with the negative carbon of the arc (*see* Fig. 16), but not when its positive pole is in connection with the negative carbon. On examining the third or middle carbon after it has been employed in this way for some time we find that its extremity is cratered out and converted into graphite, just as if it had been employed as the positive carbon in forming an electric arc. Time forbids me to indulge in any but the briefest remarks on these experiments; but one suggestion may be made, and that is that they seem to indicate that the chief movement of carbon molecules in the electric arc is *from* the negative *to* the positive carbon. The idea suggests itself that, after all, the cratering out of the positive carbon of the arc may be due to a sand-blast-like action of this torrent of negatively-charged molecules which are projected from the negative carbon. If we employ a soft iron rod as our lateral pole, we find that, after enduring for some time the projection of the arc against it, it is converted at the extremity into *steel*.

Into the fuller discussion as to the molecular actions going on in the arc, the source and nature of that which has been called the counter-electromotive force of the arc, and the causes contributing to produce unsteadiness and hissing in the arc, I fear that I shall not be able to enter, but will content myself with the exhibition of one last experiment, which will show you that a high vacuum, or, indeed, any vacuum, is not necessary for the production of the "Edison effect." Here is a carbon-horseshoe-shaped conductor, not enclosed in any receiver (see Fig. 17). Close to the negative leg or branch, yet not touching it, we have adjusted a little metal plate. The sensitive galvanometer is connected between this metal plate and the base of the other or positive leg of this carbon arch. On sending a current through the carbon sufficient to bring it to bright incandescence, the galvanometer gives indications of a current flowing through it, and

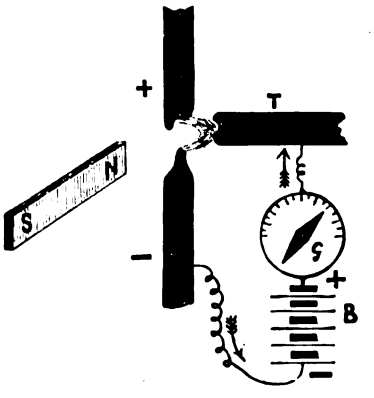


FIG. 16.—Galvanometer *G* and battery *B* inserted in series between negative carbon of electric arc and a third carbon to show unilateral conductivity of the arc between the negative and third carbons.

as long as the carbon endures, which is not, however, for many seconds, there is a current of electricity through it equivalent to a flow of negative electricity from the plate through the galvanometer to the positive electrode of the carbon. The interposition of a thin sheet of mica between the metal plate and the negative leg of the carbon loop entirely destroys the galvanometer current.*

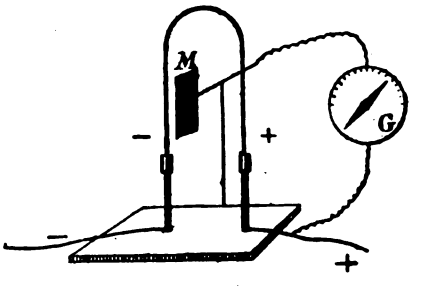


FIG. 17.—"Edison effect" Experiment shown with carbon in open air.

These experiments and brief expositions cover a very small portion of the ground which is properly included within the limits of my subject. Such fragments of it as we have been able to explore to-night will have made it clear that it is a region abounding in interesting facts and problems in molecular physics. The glow lamp and the electric arc have revolutionised our methods of artificial lighting, but they present themselves also as subjects of scientific study, by no means yet exhausted of all that they have to teach.

THE TELEGRAPH IN DENMARK.

BY CARL V. HANSEN.

Prior to the introduction of the electric telegraph the semaphore system was in vogue in Denmark as elsewhere, and to a certain extent met the demand for rapid communication. After the discovery of electro-magnetism had led to practical results, the countrymen of Hans Christian Oersted were among the first to introduce the electric telegraph as a rapid means of communication. In 1839 a short line was erected in Copenhagen. It was, however, not until 1850, after the war with Germany, that the Government commenced to collect information on the subject from

* This last experiment is due to my assistant, Mr. A. H. Bate.

Digitized by Google

countries where the system was already in active use. A Bill relating to the erection of electric telegraphs passed the Danish Parliament in 1852, and it was resolved that the construction and working of the line should be entrusted to an officer of the Royal Engineers who had acquainted himself with the subject during a stay abroad.

An underground line was commenced between Elsinore and Hamburg, consisting of a copper wire surrounded by a covering of gutta percha, and placed in a leaden tube, but the insulation failing, it was necessary to take the line up again. After surmounting considerable difficulties the line, 240 miles in length, was completed and opened for traffic on February 1, 1854, but broke down temporarily that very day owing to a landslip. On January 1, 1855, a cable was laid across the sound from a point near Elsinore to Helsingborg, establishing communication between Denmark, Sweden, and Norway. The first telegraph lines, both short, in Sweden and Norway, were opened in 1853 and 1854 respectively. Meanwhile, in Denmark the difficulties of maintaining and working a subterranean line increased, and considerable trouble being experienced in despatching even the few messages, about 80 a day, handed in, it was resolved to abandon the underground wire and adopt the overhead system which was being worked in Germany. An aerial line, 628 miles in length, with 1,700 miles of wire and 27 offices, was opened on January 1, 1857, but, owing to the use of bad material, great difficulties were experienced in that damp and stormy climate in maintaining the lines and obtaining a sufficiently high insulation. In 1860 a direct Danish-English cable was laid, and as this increased the traffic the efficient working of the Danish landlines became more urgent and it was decided to abandon the old system and construct new and overhead lines with impregnated wooden poles and galvanised wire. The poles were cut in the great forests near Soroe, from which place more than 100,000 have been sent out, and were treated according to Boucherie's method. Some are still sound and standing after 20 or 30 years. A new porcelain insulator, for which a Danish labourer invented the screw, was adopted, and No. 5 galvanised iron wire was used for the international lines and No. 7 for the local circuits, the new lines being completed in 1863. Meanwhile lines connected with the State system were carried to the more retired parts of the country by private enterprise, all these lines being bought up by the State in 1871. The war with Germany and Austria in 1864 retarded the development of the Danish telegraphs for some years, and the loss of Schleswig and Holstein diminished the total length of its system by 400 miles. During the war the telegraph clerks followed the army and maintained communication between the different corps.

The establishment of the Great Northern Telegraph Company caused a great increase in the transit traffic. This company successfully connected the following countries by cable, with Fredericia in each case as the terminal office in Denmark :—In 1867 a cable was laid to Norway, in 1868 direct submarine connection was made with England, in 1869 a cable was submerged from Russia to Bornholm and the coast of Seeland, in 1873 an ocean line was laid between Fanoe and Calais and from Frederikshaven to Gothenburg in Sweden, thus embracing all the countries in the centre of which Denmark is situated. Fredericia may be regarded as perhaps the most important of all the telegraph stations in Northern Europe, because probably no other town is connected with so many foreign countries. The clerks there number between 80 and 90, and they work 35 Morse instruments, one Wheatstone duplex system to Copenhagen, and four Wheatstone circuits to the cables, where the ordinary receiver has been replaced by a fast-working recording apparatus, officially called "the Undulator," but familiarly known as "the Snake," which is able to receive from a Wheatstone transmitter at the rate of over 100 words a minute.

The number of telegrams (received and forwarded) dealt with at Fredericia has increased from 775,696 in 1879 to 1,462,930 in 1888. The messages handed in at Copenhagen have increased from 50,298 in 1865 to 192,946 in 1875, and to 344,297 in 1888. The development of the Danish telegraphs will be seen from the following figures :—

	1879.	1888.
No, of Telegraph Stations	124	165
No. of Telephone Stations	3—	40
No. of Staff	76	483
No. of Telegrams	969 123	1,525,268
Length of line (miles, English)	1,829	2,292
Length of wire (miles „)	4,842	6,205

The Leclanché cell is exclusively used in Denmark, and the open circuit system is employed, except on some less important lines, where several stations are placed in the closed circuit, which works well. The total number of telegrams exchanged between Denmark and some of the most important countries in 1888 is shown below :—

Germany	175,617	Russia	30,835
England	143,252	France	11,647
Sweden	91,468	Holland	9,033
Norway	36,166		

At first the charge for inland messages was at the rate of 2s. 2d. for 20 words, but it is now only the equivalent of 6½d. for 20 words, and half that amount for every additional 10 words or less. Owing to the comparatively short distances between the towns, the good roads, and the railways, the post is a formidable rival to the telegraph ; still more so, however, is the telephone. In every town and in many villages there is a central telephone bureau, enabling one to converse with friends in other towns within a circle of 30 to 40 miles, and these lines are being rapidly extended. Most of the telephone wires are of Bessemer steel wire No. 14, carried on the tops of the houses. In Fredericia silicium copper wire 1·25mm. is employed.

The director of telegraphs receives £270 per annum, the engineer £200, managers of stations £140 to £155, clerks in charge £112 to £122, male operators £55 to £100, and female telegraphists £45 to £65. From an English point of view these salaries may look small, but in Denmark they are considered fairly good. Except in the case of some of the head officers, who are entitled to a pension, 5 per cent. is deducted from salaries, and a similar amount contributed by the State, towards funds to pay an annuity to widows and to provide for old and infirm *employés*.

The State has erected 50 telephone stations, principally on the west coast of Jutland. By this means the fishermen are able to communicate with fishmongers at a distance, and to get much better prices for their catch ; and, all lifeboat stations being connected by wire, the telephone is also of great service in winter in calling for assistance when a ship is in danger or ashore.

On the whole it cannot be denied that Denmark has made good use of Oersted's discovery. When extensions of the telegraph to small towns have been demanded the State has not asked so much "Will it pay ?" as will the station be of practical use in assisting the people to earn a livelihood or in saving life.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-night) FRIDAY, February 28th.

ELECTRO-HARMONIC SOCIETY.

8 p.m. Ladies' Night. Amateur Concert in the Banquet Room at the St. James's Hall Restaurant.

SATURDAY, March 1st.

ROYAL INSTITUTION.

3 p.m. Lecture : "Electricity and Magnetism." By the Right Hon. Lord RAYLEIGH, F.R.S.

MONDAY, March 3rd.

ROYAL INSTITUTION.

5 p.m. General Monthly Meeting.

SOCIETY OF ENGINEERS.

7:30 p.m. Ordinary Meeting. Paper to be read : "The Application of Water-Pressure to Machine Tools and Appliances." By RALPH H. TWEDDELL, M.Inst.C.E.

TUESDAY, March 4th.

ROYAL INSTITUTION.

3 p.m. Lecture : "The Post-Darwinian Period." By Prof. G. J. ROMANES, F.R.S.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Monthly ballot for members. Papers to be read with a view to discussion : "The Hawkesbury Bridge, New South Wales." By C. O. BURGE, M.Inst.C.E. "The Construction of the Dufferin Bridge over the Ganges at Benares." By F. T. G. WALTON, M.Inst.C.E. "The New Blackfriars Bridge on the London, Chatham, and Dover Railway." By G. E. W. CRUTTWELL, M.Inst.C.E.

WEDNESDAY, March 5th.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Paper to be read : "Recent Progress in British Watch and Clock Making." By JULIAN TRIPPLIN.

FRIDAY, March 7th.

PHYSICAL SOCIETY.

5 p.m. Ordinary Meeting. Paper to be read, "Bertrand' Refractometer." By Prof. SILVANUS THOMPSON, D.Sc

ROYAL INSTITUTION.

9 p.m. Lecture : "Electrical Relations of the Brain and Spinal Cord." By FRANCIS GOTCH, B.Sc.

SATURDAY, March 8th.

ROYAL INSTITUTION.

3 p.m. Lecture : "Electricity and Magnetism." By the Right Hon. Lord RAYLEIGH, F.R.S.

SOCIETY OF ARTS.

3 p.m. Popular Lecture : "The Atmosphere." By Prof VIVIAN LEWES.

Digitized by Google

The Electrician.

Published every Friday. Price Fourpence; Post Free, Fourpence Halfpenny
Editorial, Publishing and Printing Offices:

No. 1, SALISBURY COURT, FLEET STREET, LONDON, E.C.

Telephone No. 2714. *Telegrams:* "ELECTRICIAN NEWSPAPER, LONDON."

All Communications to be addressed to "THE ELECTRICIAN," *1, Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN."

All letters intended for insertion in "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. Subscribers should receive their copies by the first post on Friday morning.*

"THE ELECTRICIAN" *is on sale at the railway bookstalls throughout the United Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices as above*

SPECIAL NOTICE.

Owing to the increase in the number of pages of "THE ELECTRICIAN," in order to partly cover the increased postage, we have been compelled to revise the rates for Foreign Subscriptions, which are now as follows:—

	3 months.			6 months.			12 months.	
	s.	d.		s.	d.		s.	d.
For Foreign Parts and Colonies:—								
Within Postal Union	6	6	...	12	6	...	24	0
Aden, Borneo, Ceylon, China, India, Japan, Java Labuan Mozambique, New Caledonia, Persia, Philippine Islands, Siam, Transvaal, and Zanzibar	7	6	...	14	6	...	28	0
The rates for the United Kingdom remain as follows:—	5	0	...	10	0	...	19	6

TO ADVERTISERS.

"THE ELECTRICIAN" *offers exceptional advantages to Advertisers.* **It has the largest circulation of any English Electrical paper, and circulates all over the World.**

Particulars relating to Advertisements will be promptly forwarded on application to the office.

TRADE ADVERTISEMENTS *intended for the current issue must be handed in not later than First Post on Thursday morning.*

SMALL PREPAID ADVERTISEMENTS *(for Rates see page xv.) are accepted up to 4:30 p.m. on Thursday.*

TECHNICAL PRINTING.

"THE ELECTRICIAN" PRINTING AND PUBLISHING COMPANY (LIMITED) *beg to inform Electricians, Electric Light Engineers, &c., that they make a specialty of Technical Printing, and have a Staff thoroughly acquainted with Electro-Technology. They can, therefore, promise Accuracy and Despatch in the Printing of Electrical Catalogues and Electro-Technical Literature generally.*

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.

Royal 8vo, 5s., postage extra.

Early in each year is issued "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK. *The* DIRECTORY *was established in 1883, and the 1889 Edition consisted of more than 600 pages of printed matter. The names and addresses of all persons engaged in the Electrical Industries may be relied upon as accurate. Useful Tables and Electrical Formulæ, and information specially compiled for this work are given, together with popularly-written Biographical Notices of the leading Electricians, Electrical Engineers, &c., accompanied in many cases by Portraits.*

The issue for 1890, which is still further enlarged and improved (making 850 pages), is NOW READY. Orders should be forwarded at once to the Publishing Offices, Salisbury-court, Fleet-street, London, E.C.

CONTENTS OF THE CURRENT NUMBER.

NOTES 411
Magnetism in Iron and other Metals.—VII. By Prof. J. A. Ewing, F.R.S. Illustrated. Continued 415
Problems in the Physics of an Electric Lamp. By Prof. J. A. Fleming, M.A., D.Sc., M.R.I. Illustrated. Concluded 417
The Telegraph in Denmark. By Carl V. Hansen 420
Meetings of Scientific Societies. 421
UNDERGROUND SYSTEMS OF DISTRIBUTING ELECTRICITY 422
The Institution of Electrical Engineers—
Some Points in Dynamo and Motor Design. By W. B. Esson, Member. Illus..... 423
The Wynne System of Urban Electric Traction. Illustrated 427
Physical Society—
"On a Carbon Deposit in a Blake Telephone Transmitter" 428
"The Geometrical Construction of Direct Reading Scales for Reflecting Instruments." Illustrated... 428
The Electrical Distribution of Energy by the Three-Wire System. Illustrated 429
American Notes 430
Paris Notes 431
Brussels Notes 431
Books Received..... 431
CORRESPONDENCE—
Life and Efficiency of Glow Lamps.—C. J. Robinson... 432
Telephones for Domestic Use. —W. J. M. Menzies..... 432
Carrara Electric Light.—Denny Lane 432
The Ether Theory of 1839.—James Johnstone 432
LEGAL INTELLIGENCE—
Chatenay *v.* Brazilian Submarine Telegraph Company 432
Trade Notes and Notices 433
PATENT RECORD 433
COMPANIES' MEETINGS, &c.—
The Notting Hill Electric Lighting Company (Ltd.).. 434
The Telegraph Construction and Maintenance Co. (Ltd.) 435
New Companies Registered ... 435
City Notes, &c..... 435
Companies' Share List 436

"THE ELECTRICAL WORLD" OF NEW YORK.

"THE ELECTRICAL WORLD" OF NEW YORK *can be obtained from* "THE ELECTRICIAN" *Office, Salisbury-court, Fleet-street, London, E.C. The Rate of Subscription (payable in advance), is* **£1 1s.** *per annum. Single Copies* **price 6d. each; post free, 8d.**

UNDERGROUND SYSTEMS OF DISTRIBUTING ELECTRICITY.

Granting the truth of the maxim that there is safety in numbers, the condition of the underground distribution problem may well be considered healthy. Indeed it would almost seem as though the central station engineer were more likely to be overwhelmed by a plethora of systems than deterred by the lack of a satisfactory one. It may safely be said that in no branch of the electric industry has greater progress been made within the last two or three years than in this. We can congratulate ourselves, not only on the improvements which have taken place, but also on the increased confidence which the satisfactory working of underground systems in the meantime has inspired. This is particularly the case with mains for high-tension currents. Three years ago it was still an open question whether the distribution of such currents underground was commercially practicable, but of this there can no longer be any reasonable doubt; and while it is true that further improvements may still be looked for, the fact that it can be carried out in more than one way has been fairly proved.

The series of articles on underground mains concluded in our last number, and which has brought this subject prominently before our readers, makes it manifest from how many different standpoints workers in this field have proceeded. For the moment perhaps the number of complete "systems" may be somewhat a matter of regret, as tending to retard progress in the immediate future, but from the engineering side, the accumulated experiences which the commercial operation of all these different methods of constructing underground mains will furnish must result in the collection of a great number of important data which will bear good fruit later on. At the same time, it seems probable that, even when high and low tensions are taken into account,

Digitized by Google

there may never be quite the same uniformity in the methods of distributing electricity that has come to be the case with water and gas, since the distribution of electric current through copper conductors is a problem of a more elastic nature, if we may so term it, than that presented in the distribution of water and gas, and therefore admits of a greater variety of treatment.

Turning now to the systems themselves, it is satisfactory to find that wherever pipes or conduits have been used the difficulties which it was thought would arise from water getting in, and from general dampness have proved less than was anticipated. When the possibility of using bare conductors underground was first mooted, the chance of water filling the conduits was one of the strongest objections brought forward against their employment; and therefore it is pleasing to find the supposed difficulty has proved quite a bugbear, and that while the leakage of water into the pipes or conduits is usually small, it is, moreover, easily disposed of when it does happen. No doubt differences will be found in this respect in different localities, according as the soil is porous and dry or clayey and moist, and as the drainage is good or bad; but with the experience now gained there should be no great difficulty in dealing even with unfavourable conditions. The increase in the use of bare conductors, on insulating supports, for low-tension currents is a matter deserving close consideration, and has much to recommend it. While the conductors themselves are in their cheapest form, the durability of all the materials employed is beyond question, and when, as is often the case, the size of the feeders is calculated so that the fall of potential at full load is as nearly as possible the same on each, this method of construction does away with any chance of ill effects from heating the shorter feeders, on which the fall of potential is greatest. As yet the question has hardly come to the fore, but in view of the extension of electric lighting, when space under the roadway and footpaths will become even more valuable than at present, it would be interesting to have an approximate estimate of the relative amount of room which a given section of bare copper strip on insulators would occupy as compared with a similar section in cables. There is another thing about these bare copper conductors which recommends them, namely, that local connections are so easily and cheaply made. This is a matter of considerable importance in estimating the relative cost of different methods of construction, for if a conductor is cheap but requires expensive junction-boxes, it may be more expensive for local services when connections are frequent than a more costly conductor, but to which junctions are easily and cheaply made. While, however, thus speaking well of bare conductors we do not wish to decry such solid work as that in which the cables are laid in bitumen. There are elements of safety and durability which recommend this method, for in the bitumen we attain additional insulation and a perfect preservative. It has the merit of adapting itself easily to circumstances, and gets rid of questions of drainage and dampness of the soil, while differences of level are of secondary importance. The fact that this method has been so largely used, and at the same time so little has been said about it, is much in its favour, for underground mains when once they are in their places must be classed in the category of those things of which the less that is heard of them the better. The relative desirability of all the systems in use depends now chiefly on their cost, durability, and convenience. Of their relative cost much will depend on circumstances, and as to the two latter items, at present they must remain largely a matter of opinion, which only the experience of further use and the lapse of time can finally decide satisfactorily.

For high-tension work we find almost, if not quite, as great a variety of methods as for low tensions, though so far the largest experience seems to have been with Siemens' concentric cables in Italy and india-rubber-covered cables in England. India-rubber has indeed done yeoman service in this respect, and although on account of its expense a thoroughly efficient substitute would be very welcome, yet we think that companies employing high-tension currents would be wise to pause for the present, and very carefully weigh the question before adopting other means of insulation. Although the practicability of conveying high tensions underground has been thoroughly proved, yet there are, unfortunately, several things which make the public at present timid and observant when such currents are employed. Now, the great elements of success in central station supply are reliability and freedom from interruptions, and to sacrifice these in any way is to lose public confidence, which, once destroyed, is not easily attained again. Experiments with high-tension mains should therefore be tried on a small scale and where failure will disturb the rest of the supply as little as possible. The use of anything found satisfactory can then be afterwards extended, with thorough confidence in its ultimate success.

Altogether the future of underground distribution appears full of hope. Of the chief difficulties which beset it the back has been broken, and it has come into commercial use on a large scale. With the additional stimulus which the concurrent working of rival systems furnishes, further improvements in detail in all the various systems in use must rapidly take place, and we may confidently expect that little time will elapse before this portion of central station work has reached as great perfection as the rest.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

SOME POINTS IN DYNAMO AND MOTOR DESIGN.*

BY W. B. ESSON, MEMBER.

Though the recent progress in dynamo construction has been of a highly satisfactory character, there still remain several points affecting design which have received but inadequate attention, and to which reference is seldom made outside the drawing office. In the present Paper a few of these unsettled points will be brought before the Institution in the hope that a full discussion will enable us to make some progress towards a solution of the various questions raised.

1. Magnetising Force for a Simple Magnetic Circuit.

Foremost amongst the factors which have contributed to the progress of recent years has been a more perfect comprehension of the laws of magnetic induction, and now, knowing the magnetic properties of the iron with which we deal, it is a perfectly easy matter to determine the magnetising force required to produce in any simple magnetic circuit of given configuration a specified induction. The formula of Drs. J. and E. Hopkinson, which was published in the *Philosophical Transactions* in 1886, is now adopted by most designers who desire to economise their time. Reduced to ampere turns, this formula for the magnetising force is—

$$A_1 = L f\left(\frac{N}{a}\right) + L_1 \cdot 8 \frac{v_1 N}{a_1} + L_2 f\left(\frac{v_2 N}{a_2}\right) + L_3 f\left(\frac{v_2 N}{a_3}\right) + \ldots.$$

Here A_1 is the magnetising force; L, L_1, L_2, and L_3, are the mean lengths, in centimetres, of the separate parts which constitute the magnetic circuit—comprising in this case armature core, air gaps, magnet limbs and yoke—while a, a_1, a_2, and a_3, are the cross sections, in square centimetres, of these several constituents. Owing to the spreading of the induction, it is necessary to assume the air gaps as having an extension beyond the polar area equal to ·8 of the distance between the armature core and the polar surface. Of the induction produced in the magnet cores, only the portion N, which passes through the armature and is enclosed by the coils at the brushes, is serviceable, the lines of force which choose a path outside the armature constituting a stray field which cannot be utilised. In

* Read before the Institution on February 20, 1890.

Digitized by Google

the above expression v_2 is the ratio of the induction in the magnets to that in the armature, the total lines induced being therefore v_2 N. Since in cylinder armatures some of the lines stray through the internal opening, in these the induction in the air gaps will be greater than N. If we call v_1 the ratio of the lines in the gap to the lines in the armature, the lines in the former will be v_1 N. The functions $f\left(\frac{N}{a}\right), f\left(\frac{v_2 N}{a_2}\right)$, &c., are read directly off the curves Figs. 1 and 2, where ordinates give the induction per square centimetre, and abscissæ the corresponding ampere-turns required per centimetre length. These curves are reduced from the results of Dr. John Hopkinson.

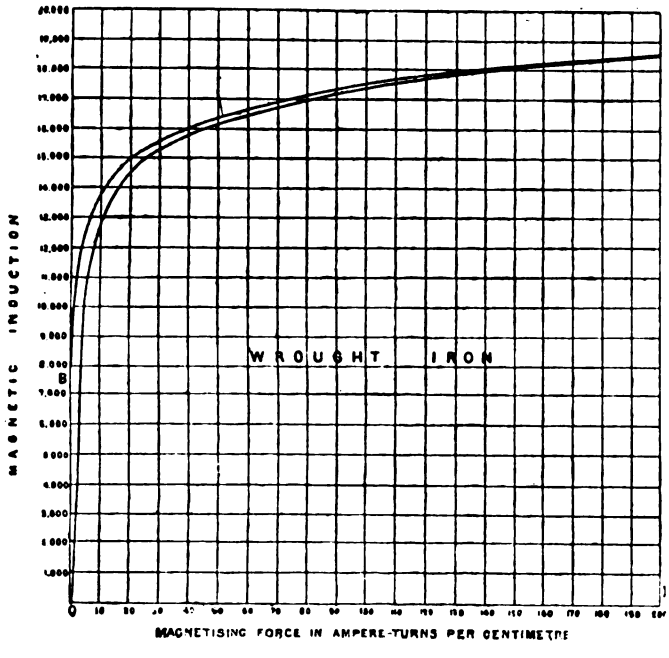


FIG. 1.

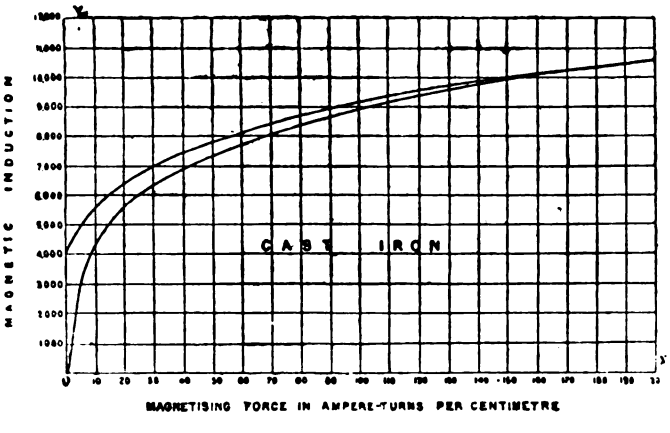


FIG. 2.

2. MAGNITUDE OF THE STRAY FIELD.

The expression in section 1 gives a general formula for any configuration of magnetic circuit, but in order to employ it, we require to know the values of v_1 and v_2, or, in other words, we must know the magnitude of the stray field. To be quite accurate, we should know the exact distribution of the field, for in any particular machine v_2 has evidently a different value at every part of the cross section. In the absence of actual measurement, however, its mean value can only be guessed at from a knowledge of machines of similar type.

The value of v_2 in different types of machines depends not only on the shape of the magnetic system, but on the position of adjacent masses of iron in bed-plates, bearing brackets, fly-wheel, &c. Calculations undertaken with a view to ascertaining its value from a knowledge of the shape of the machine, without reference to previous machines, are necessarily of a laborious character, and the labour in the end leads to no great accuracy. But I find that a very close approximation to the truth may be arrived at by taking the known value for some particular type of machine, and considering step by step the effect produced in the stray field by the changes in the dimensions and shape. It must be remembered that no two machines of the same type have exactly the same value of v_2 unless their dimensions correspond in every particular. Every alteration to the patterns, and every modification in the details, introduce a new value for this ratio. Our calculations, therefore, must be to a great extent guesswork. We cannot help it. If the guess is a good one, we congratulate ourselves on the soundness of our judgment, or on the accuracy with which we make our calculations. If it is a bad one, we write to the forge about the annealing of the iron.

The values of v_2 have been ascertained for the following machines, and it will be found, probably, that for all modern types they lie between these limits. With these values to guide us, we cannot go far astray in new designs.

TABLE I.—*Stray Field in Different Dynamos.*

Name of Machine.	Field.	Armature.	Remarks.	Value of v_2
Edison-Hopkinson.	Single Magnet, 2-pole	Drum	Poles next bed-plate	1·32
Siemens	Single Magnet, 2-pole	Drum	Yoke next bed-plate	1·30
Phœnix.....	Single Magnet, 2-pole (Fig. 8)	Cylinder	Yoke next bed-plate	1·32
Phœnix.....	Double Magnet, 2-pole (Fig. 3)	Cylinder	Horizontal	1·40
Manchester	Double Magnet, 2-pole	Cylinder	Bed and one pole cast together	1·49
Victoria	Double Magnet, 4-pole	Ring	Ordinary pattern	1·40
Ferranti	Double Magnet, Multipolar	Coreless Disc	Ordinary pattern (alternating)	2·00

The measurements of the Edison-Hopkinson and Manchester machines were made by Drs. J. and E. Hopkinson, of the Victoria by Mr. Mordey, of the Ferranti by Dr. W. E. Sumpner, and of the Phœnix by myself.

When the linear dimensions of a machine are increased in the same proportion, v_2 remains approximately unaltered. Suppose, for example, that all the dimensions of a magnetic system are increased n times. If the induction per square centimetre is the same, the total flux of lines is n^2. The cross-section of all the paths for stray lines are increased to n^2, and the distances between adjacent surfaces are increased n times. The lengths and cross sections of the stray paths are therefore increased in the same proportion as the useful paths, and the ratio between useful and useless lines is unchanged. If, the length of the magnetic circuit remaining the same, both dimensions of the cross section are increased n times, making the area n^2, the total flux through the machine is n^2; and since the cross-sections of the stray paths are n^2 times greater, the value of v_2 remains as before. If the length of every part of the magnetic circuit is increased in the same proportion, while the cross-section remains the same, v_2 is increased somewhat, owing to the increase in the cross-section of the stray path. If the dimension of either factor of the cross-section is increased, while the other is unchanged, and the length of the magnetic circuit remains the same, v_2 is reduced, its reduction depending upon the ratio of the two factors of the cross-section.

As the exact value of v_2 is a matter of some doubt until the machine is built, it may be instructive just to notice upon what the difference in the calculated flux through the armature, and the actual flux as modified by an error in the estimation of the stray field, depends. Assuming that we can measure accurately the path of the induction in the armature—often a matter of uncertainty—the magnetising force for the armature and the air gap can be determined independently of the magnitude of the stray field. The magnetising force to be allowed for the magnets depends, however, on the amount of stray field we assume. Imagine that in designing the machine we estimated a certain value for v_2, which turns out, when the machine is built, to be too low. Now the reduction in the flux through the armature due to this error will depend upon the magnetising force required for the magnets as compared with that required for the rest of the machine, and on the difference in the magnetising forces necessary for the induction in the magnets under the real and assumed values of v_2. If these two quantities are large, the error will be considerable, increasing as the magnets are more saturated, and as their resistance in proportion to the other components of the magnetic circuit increases. If the difference in the magnetising forces for the real and assumed values of v_2 is small, the converse holds good, the error being small in proportion. In the Edison-Hopkinson machine, for instance, the magnetising force required for the magnets is rather over one-eighth of the whole machine, and the value of v_2 is given in the table as 1·32. If in this machine an erroneous value of 1·25 had been estimated in designing, the diminution of the flux through

Digitized by Google

the armature, with the calculated ampere-turns so allowed for, would be only about 2 per cent., *i.e.*, the machine, to give the same output, would have to run at 765 revolutions instead of 750. If the magnets were saturated to a greater degree, or constituted a larger proportion of the magnetic resistance, the error would be correspondingly greater.

It must be noticed that the values in Table I. are given at the working saturation of the machine. As the bending in the magnetisation curve of the iron becomes more pronounced, v_2 increases. In actual machines we work above the bend, and with a reduced saturation v_2 would be less than given in the table. In practice, differences in the quality of the iron lead to much greater errors than are likely to arise from an error in the estimation of the stray field.

3. Symmetry of the Field.

It is of some importance to obtain a symmetrical field through the armature, as it is only when the field is symmetrical that the

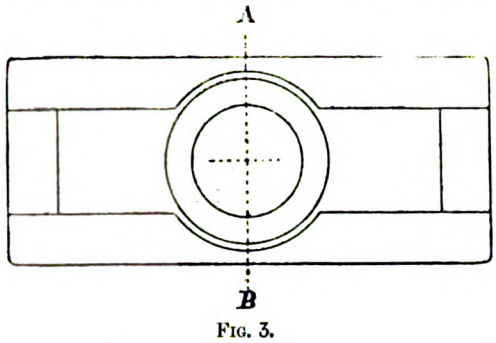


Fig. 3.

armature is electrically and magnetically balanced. Looking at Fig. 3, it will be observed that a line, A B, drawn diametrically across the armature divides it into two halves, which are perfectly similar as regards distribution of field ; and, generally, this is true of all machines in which there is a double magnetic circuit. There

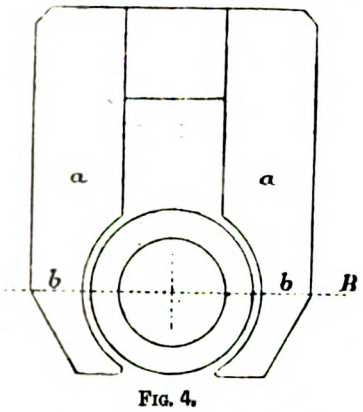


Fig. 4.

is here no tendency of the armature to move laterally in the field, providing its centre is concentric with the bore of the polar cavity. But with single magnet machines it is different. In Fig. 4, for example—which is about the worst form of magnet, on account of the section being reduced at *b* to half what it is at *a*—there is a

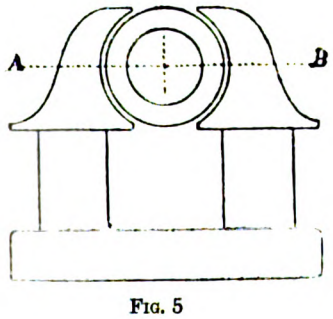


Fig. 5

strong upward magnetic pull, producing an abnormal pressure on the bearings, which may under some circumstances lead to serious trouble from heating. Most makers of single magnet machines have experienced some trouble from this cause, and have adopted, with more or less success, some means of curing the evil. A remarkable instance of the heating due to magnetic pressure on the bearings was recently brought to my notice by M. Heilmann, of the Société Alsacienne de Constructions Mécaniques, of Belfort. In the inverted machines first constructed by this Company, the magnet cores (Fig. 5) were of wrought iron, on the top of which were fitted cast-iron pole-pieces of comparatively small mass. From the look of the thing one would expect a very considerable downward pull, and in the case of some machines of 60,000 watt capacity the pressure on each bearing due to magnetic pull reached the high figure of 1,500 pounds. This, of course, led to serious heating, and in later machines the cylindrical wrought-iron cores have been continued to the top of the machine, as shown in Fig. 6, being fitted with cast-iron shells, which, together with the wrought-iron limbs, form, when bored out, the polar cavity. It will be noticed that the reduction in the section of the wrought iron due to boring out is very small, and I am informed that in this design the evil of heating has been completely abolished, a practically symmetrical field being produced. These machines are of the drum type.

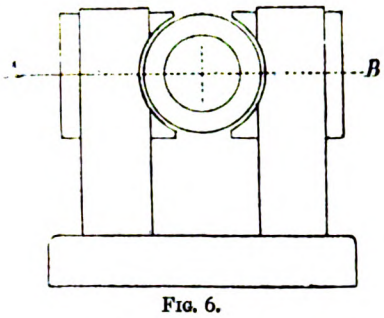


Fig. 6.

In well-designed machines of the single-magnet type there need be no trouble, however, from magnetic pull on the armature. The first essential is that the section at the thinnest part of the magnet be reduced as little as possible. The form in Fig. 6, for example, where this is carefully attended to, may be cited as an example of good design ; while that in Fig. 4 illustrates a magnetically bad design. Since the induction always takes the path of least resistance, the importance of keeping up the full section of the limbs at the poles, in order that the resistance due to saturation may not cause unequal distribution of the field, will be obvious.

The magnetic pull may be balanced by the very simple device of placing the armature eccentrically in the field, as I suggested two years ago,* its centre being somewhat farther from the yoke than the centre of the polar cavity. In some cases the magnets, after boring out, have been brought closer, so that the air gap increases

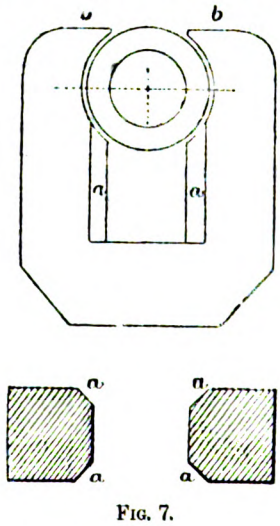


Fig. 7.

gradually to the polar tips ; but though the pull is reduced to some extent by these means, the device is not so efficacious as the one previously mentioned. I understand that in order to reduce heating this latter course had to be adopted in the machines built for the Bradford Corporation, the magnets in these being somewhat similar in shape to that shown in Fig. 4.

Electrically there is in drum armatures no want of balance due to an unsymmetrical field, as every convolution of the conductor encloses the whole of the lines of force passing through the armature core. The only result of a want of symmetry is that the position of the brushes on the commutator for a sparkless collection may become more marked, and the variation of current possible without readjustment of the brushes therefore less. But in cylinder-wound armatures not only is there a want of magnetic balance

* *The Electrician*, Vol. XX., page 114, 1887.

Digitized by Google

when the field is unsymmetrical, but from the fact that each convolution encloses only half the lines passing through the core there is a want of *electrical* balance, and it becomes, in consequence, doubly important to get a symmetrical induction, or the same number of lines through each half of the armature. Though the lines were unequally divided there might not be any appreciable difference in the E.M.F.s generated in each half with the brushes diametrically opposite; but from the fact that a want of electrical balance requires rather more lead to be given to the brush farther from the yoke, it is possible that the E.M.F.s in the two halves of the windings may be unequal, the result being a local current round the armature, and consequent waste of power.

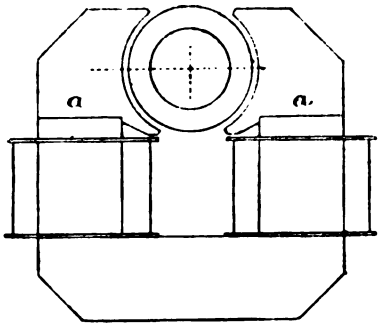


Fig. 8.

There are several methods of obtaining an approximately symmetrical field besides that already mentioned of placing the armature eccentrically in the cavity. What we have to do, if possible, is to make the path for the induction through the half of the cylinder

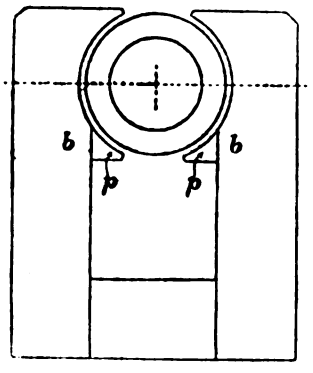


Fig. 9

core which is farther from the yoke of similar resistance to the path through the nearer half, so that a similar number of lines may flow through each. In the Phœnix dynamo we employ sometimes, with this object in view, the device shown in Fig. 7. Here the cast-iron

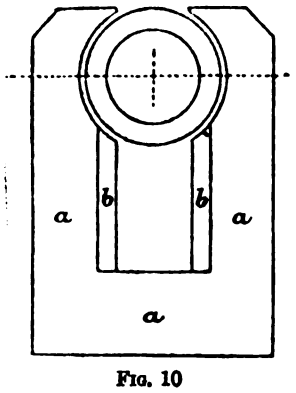


Fig. 10

magnet, instead of being rectangular in section, has the inside corners cut away, as shown in the section at *a*, the top corners at *b* being left on. In this way the magnetic resistance across the bottom path is increased, and the induction in the two halves of the armature made equal. Another plan is to shape the magnets as in Fig. 8, there being a faced joint at *a*. A plan adopted in several direct-driven ship sets we have just completed is shown in Fig. 9. The magnets are in this case of wrought iron, the limbs and top polar expansions being in one single forging, while the bottom polar expansions *p* are of cast iron. The magnetic resistance of the cast iron, combined with that of the joint at *b*, compensates for the diminished length of the induction path through the lower half of the armature. Another design by which the same end may be attained is shown in Fig. 10, where the magnet is partly of wrought iron, *a*, and of cast iron, *b*.

With a view to obtaining a more symmetrical field some single-magnet machines have been shaped as in Fig. 11. Here, to attain the object, the magnetic circuit requires to be lengthened, the magnetising force required being correspondingly greater. In Fig. 12 is sketched a single-magnet machine in which the field is quite symmetrical, although here the magnetic circuit has been made still longer.

It will be understood that it is possible to have an armature out of balance magnetically while electrically it is perfectly balanced, as, for example, a drum armature in the misshapen field, Fig. 4.

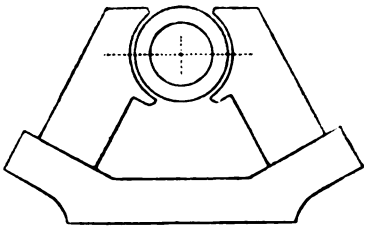


Fig. 11.

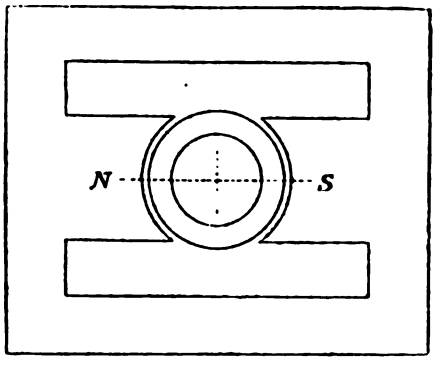


Fig. 12.

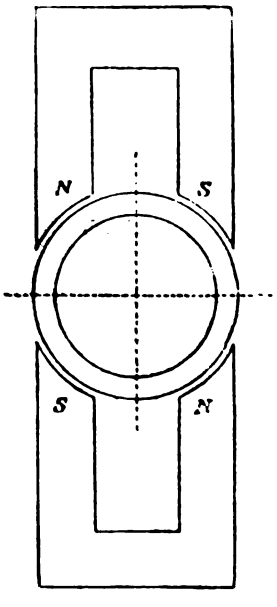


Fig. 13.

On the other hand, it is possible to have magnetic balance while electrically there is want of balance, as may be the case when a cylinder armature is placed in the four-pole field, Fig. 13.

When the armature core is carried round by spider arms, which fit into slots in the iron washers, it is important that the reduction of the core area due to these slots be as small as possible. Variation in the section causes magnetic kicks, or periodic fluctuations in the field during rotation.

(*To be continued.*)

Digitized by Google

THE WYNNE SYSTEM OF URBAN ELECTRIC TRACTION.

The following report, signed by Messrs. W. M. Mordey, John Raworth, and N. Scott Russell, has been sent us for publication :—

We have lately had an opportunity of examining a scheme which bids fair to solve the problem of electric traction on tramcars without the use of open conduits or accumulators. Mr. Frank Wynne, of 5, Westminster-chambers, is the inventor of the new system, in which power is transmitted from the engine to the car as directly as by rope traction, without the objectionable necessity of cutting a continuous slot in the roadway. Mr. Wynne has been engaged in endeavouring to solve the problem of urban electric tramways for upwards of four years. His efforts have been watched with keen interest by engineers and electricians in England, and the skill and foresight with which he has approached the subject have met with general recognition. While electricians and tramway companies in this country have been experimenting with accumulators and slotted conduits, tram lines with overhead conductors have been carrying all before them in America, and excellent commercial results have been obtained. The method of transmitting power to a tramcar by an overhead conductor, though well suited to new and rapidly developing districts, is absolutely inapplicable to English and most Continental cities, and no serious attempt has ever been made to introduce them in this country.

Fig. 1.

Mr. Wynne's new system secures all the advantages of an overhead conductor system without any of the constructive disadvantages of an open conduit. Among the chief advantages of the overhead system are that it enables ordinary permanent way to be utilised without reconstruction for heavier weights, and it allows of existing cars being used with some modifications. These advantages hold to the fullest extent in Mr. Wynne's system, the object of which is to enable the electric current to be transmitted direct from the generating station to the car motors through an insulated cable laid underground, after the manner of electric light cables, with absolute safeguards against the possibility of including any of the ordinary traffic of the street in the electric circuit. The current used is that known as the low-tension continuous current.

In the centre of the track is laid a crenellated contact plate or rail (*see* Fig. 1) in short sections. This contact plate or rail is not straight, but is formed to follow the junction line of the sets thus :— It is half-an-inch wide on the surface and about 4½ inches deep, it offers no obstruction to carriages crossing the track, and affords a good foothold for horses. Mr. Wynne has invented a remarkably simple device whereby the sections of the centre rail are successively put in connection with the main insulated conductor as the car passes over them, and are disconnected again as the car proceeds.

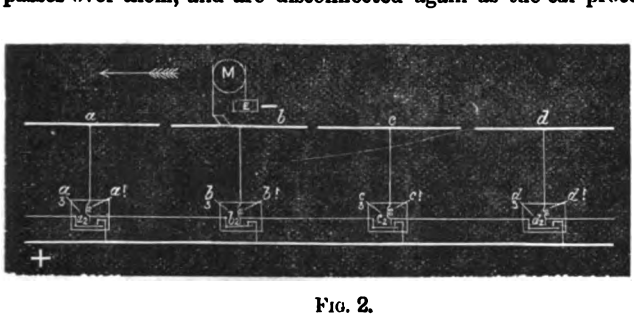


Fig. 2.

The only sections in connection with the main are those covered by the cars and its platforms : two sections are always in circuit, and a third section may be momentarily so connected as the contact brushes carried by the car pass over one of the separating spaces. The sections are necessarily short, and the inevitable leakage is therefore reduced to quite a negligible quantity.

The device for making contact with the sections of the central rail is shown in the following diagram (Fig. 2) : a, b, c, d are four sections of the sectional contact rail ; a^1, b^1, c^1, d^1 are electro-magnets traversed successively by the current passing from the main conductor + to the car motor M. a^2, b^2, c^2, d^2 are armatures and contact makers actuated severally by the electro-magnets, a^1, b^1, c^1, d^1, and are severally contained in the contact-boxes a^3, b^3, c^3, d^3. It will be noticed that as the car passes over section b, the current passing through the magnetic coil b^1 not only closes the contact in connection with its own magnet b^1, but also puts the magnet a^1 in circuit in parallel with b^1. This arrangement effectually obviates sparking, and provides that one section shall always be charged in advance of the contact brush. The contact pieces assume their original position by gravity, thus disconnecting the sections as the cars leave them. The contact boxes may be placed in any convenient position, as, for instance, in the footway or curbs, but their construction is such as to render them suitable for fixing in the tramway track. The boxes themselves are of cast iron or steel, with a grooved or "diamond" surface, and are constructed on the diving-bell principle, so that the enclosed air will absolutely debar water from rising into the interior.

It is obvious that it is an essential part of the scheme that the current should never be cut off entirely from the magnets, for under such circumstances they would break contact with the sectional rail, and the car could not proceed. Mr. Wynne has provided thoroughly practical devices both for maintaining the circuit and for re-making it in the event of accidental disturbance—as, for instance, by reason of the car leaving the rails.

Under ordinary circumstances a small percentage of the current is kept on when the motor has stopped, or when the car may be going down hill. In the event of contact being accidentally broken, the driver, by moving a lever, brings down a supplementary contact brush which closes the circuit of a single cell battery, and so re-establishes the current through the contact boxes.

There can be no doubt as to the great engineering skill displayed in Mr. Wynne's proposals, the details of which are eminently practical. The contact boxes are numerous, but there is no difficulty in adapting them to work under the conditions of a tramline, and the mere fact of the necessity of their manufacture in large quantities will reduce their cost and tend to simplify their details. This tendency is well illustrated by Lancashire cotton mills, in which 40,000 spindles are often found working all the year round, with scarcely any repairs. We are much impressed with Mr. Wynne's scheme, and consider that it is the only practical attempt that, up to the present, has been made to grapple with the real difficulties of urban electric traction. Batteries are ruinous at present prices, overhead conductors inadmissible in English towns, and open conduits are an aggravation of all the evils attendant on the use of straight rails in crowded streets. Mr. Wynne's invention has none of these drawbacks. We do not think that his crenellated contact rail would be in any way objectionable in well-laid roads such as are usually found in London and the principal provincial towns. On the question of capital cost and cost of power, we have carefully examined the accompanying estimates laid before us by Mr. Wynne, after comparing them with data derived from our own experience ; and we are of opinion that they are formed on a good commercial basis, a sufficient margin having been allowed for extras, which are inevitable in carrying out a new scheme. The estimate of capital expenditure for applying this system to an existing tramway, amounts, as shown, to £2,200 per mile of single track ; this leaves out the items of real estate and buildings, which will be much less for a line worked by electricity than for one worked by horses in which the area of ground and the buildings required for stables and granaries are very large. Against this capital expenditure of £2,200 per mile (including, as it does, boilers, engines, and dynamos for twice the maximum power required at any one time) must be set the capital cost of horses and of horse cars, amounting respectively to £1,500 and £500 per mile on the North Metropolitan Tramway, or altogether to a sum nearly equal to that for applying electricity. The large figure of 7½ electrical horse-power per car has been introduced with these estimates to cover a line with steep gradients and so make the estimate of safe general application. American experience shows that this is an ample allowance for the not very marked effect of gradients in increasing the aggregate power required.

Estimate of Capital Cost.

Tramline 4 miles in length, double track.
Generating station in centre, 2 miles from each end.
Average speed, 7 miles per hour.
Ten minutes' service.
Cars spaced 2,000 yards. apart.
Total cars in action at one time, 7.
Electric horse-power per car, 7½ = 5,600 watts.
Total electric horse-power, 52½ = 40,000 watts.
Voltage at generating station, 250.
Maximum loss 15 per cent. = under 40 volts.
Amperes per car in middle of line, 20.
Amperes per car at ends of line, 25.
Main conductor tapers in half-mile lengths from generating station to termini.

The lengths and sizes of conductors are as follows :—

2 half-mile lengths	.....	·195	square inch.
2 „ „	.....	·150	„ „
2 „ „	....	·103	„ „
2 „ „	....	·053	„ „

Digitized by Google

The most suitable cable for the purpose, having regard to the number of joints, will be Callender's bitumen insulated cable, which may be obtained at the following prices :—

1 mile ·195	£300
1 „ ·150	250
1 „ ·103	160
1 „ ·053	95
16 miles of junction wire, at £35	560
Roadwork at 2s. 6d. per yard	880
Casing at 2s. 6d. per yard	880
Joiners' work	500
Contact boxes (every 3 yards) at 15s.	3,600
Crenellated rail, 33 tons per mile, at £6 per ton	1,584
Supervision and sundries, at £100 per mile	800
Generating station for 120 E.H.P., being double the maximum power required at any one time for working the line, and including a complete duplicate plant of boilers, engines, and dynamos, at £30 per E.H.P.	3,600
11 cars (4 in reserve) complete with motor and fittings, at £400	4,400
Total	£17,609

Say £17,600 for the eight miles of single track, or £2,200 per mile.

Estimate of Cost of Power per car mile run.

It takes 1 horse-power hour to drive a tramcar one mile (this agrees with the results of extensive working in America). The cost of this, including coal, oil, waste, water, engineers, firemen, and dynamo men, with depreciation at 7½ per cent. per annum on half the generating plant, amounts to 1½d.

THE PHYSICAL SOCIETY.

At the meeting of this Society held on the 21st inst., the first communication was a short note by Mr. F. B. Hawes—

"On a Carbon Deposit in a Blake Telephone Transmitter."

The author exhibited some photographs of the diaphragm of a Blake Transmitter, on the centre of which a deposit of carbon had been formed after it had been in use for some months. The author attributed the deposit to particles being thrown off from the carbon button.

Mr. C. V. Boys stated that he had observed a deposit of a very similar character upon a sheet of glass, which had remained for some time very nearly in contact with one of the terminals of a dry pile.

Mr. A. P. Trotter then read a Paper on—

"The Geometrical Construction of Direct Reading Scales for Reflecting Instruments."

In the recent Paper by Prof. Ayrton, Mr. Mather, and Dr. Sumpner, on galvanometers, reference was made to the proportionality of deflection and current, and it was stated that the latest improvements in the D'Arsonval galvanometer had reduced the error to less than 0·15 per cent. within the ordinary limits of the instrument. The scale being flat, this means that the instrument is practically a tangent galvanometer. The improvements by which this admirable result has been obtained, are not applicable to most galvanometers, and there appears to be some difference of opinion as to its utility. The author of "Practical Electrical Measurement" says that "it is strange that so many physicists have taken so much trouble to design electrical measuring instruments to read proportionally," and adds "that when an instrument has its scale divided off into equal divisions, it must be regarded with suspicion." He has recently confirmed these views; but, since Prof. Ayrton has stated that "he does not agree that proportionality is a matter of indifference," and has observed that "it is extremely difficult to construct a 3ft. scale to follow all the vagaries of an instrument of the original D'Arsonval type," the author felt encouraged to call attention to the use of the bent scale, by which true proportionality can be obtained with the greatest ease. He was aware that this device was not new, but he had only heard of two instances in which it was regularly used.

For any reflecting instrument there are two limiting curves to which a uniformly divided scale may be bent to give the desired proportionality. The tangent to one of these curves, at the point where it cuts the horizontal axis or zero azimuth of the instrument, is perpendicular to that axis. The characteristic of the other curve is that it passes through the vertical axis of the mirror. When the angle of deflection is already proportional to the quantity to be measured, one form of the scale is obviously an arc of a circle coaxial with the mirror, but, owing to a property of the circle, the scale might be bent to an arc of half this radius—that is, of a circle passing through the axis of the mirror, and tangent to the usual scale line at the zero point (Fig. 1). Again, when the tangent of the angle of deflection is proportional to the quantity to be measured, the scale may be flat, or it may be bent to any of the curves shown in Fig. 2. The first of these curves is tangent both to the usual scale line, and to a line parallel to this, passing through the axis of the mirror. The others pass through the axis of the mirror, and are asymptotic to the scale line.

When the instrument follows some unknown law, the curves to which the scale may be bent may be found as follows, the methods being described as for a galvanometer, but, *mutatis mutandis*, they will be similar for any other instrument. Let five or six readings be taken at any convenient deflections, as, for example, those of the

Fig. 1.

ordinary reflecting galvanometer and of the ordinary D'Arsonval galvanometer, as given in the Paper already referred to. Set out the deflections on a sheet of paper, full size; the scale itself on which the readings were taken should be used if possible, and the lines drawn to converge towards a point at the scale distance. With a pair of dividers, take off on the scale a length proportional to the current or other quantity measured by the first deflection. Find two points, A and B (Fig. 3), the one on the zero line A O, and the other on the line of first deflection B P, whose distance apart

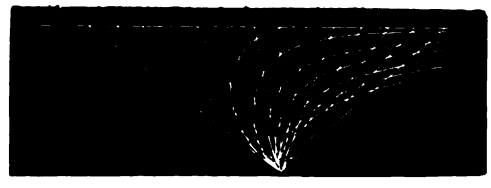


Fig. 2.

is equal to this length, and let these two points be equidistant from the point of convergence, so that the line joining them may be the base of an isosceles triangle. Then set the dividers to a length representing on the scale the increment of current required to produce the second deflection, and from the point B, the point already found on the line of the first deflection P B, mark off a point on the line of the second deflection. This process being repeated, a number of points may be found, and these, being joined by straight lines, a curve may be drawn between the inscribed and the circumscribing

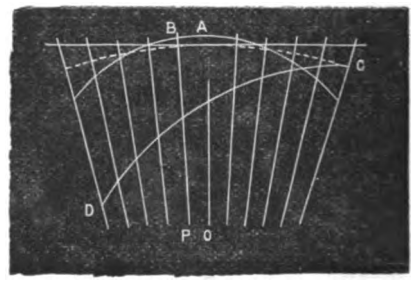


Fig. 3.

curve having the same length as the sum of the straight lines. The original scale being bent to this curve the readings will be proportional to the currents. The object of commencing with the isosceles is to produce a curve which shall be fairly continuous without any abrupt change at the point A where it cuts the zero line. The isosceles triangle is not always the best, but it is better than a right-angled triangle. This, of course, depends on the magnitude of the first increment. A slight change of curvature at the zero is of no importance.

When the sensitiveness increases with the deflection, the curvature is greater than an arc having the axis of the mirror at its centre. When it decreases the curvature is less, disappearing for a tangent instrument and becoming negative—that is, convex towards the mirror if the sensitiveness falls off very rapidly. The other limiting

Digitized by Google

curve which passes through the vertical axis of the mirror would seldom if ever be of any practical use; but between the two extremes lie a family of curves, some of which, either in whole or in part (one of these is shown at C D, Fig. 3), would be most suitable for ordinary use. The curve of least curvature would generally be the most convenient.

With an instrument which increases in sensitiveness with the deflections, to find the curve of least curvature it is best to commence with the extreme deflection, and setting the dividers to the last increment of current, find two points (A and B, Fig. 4) on the last two lines of deflection, forming the ends of an isosceles triangle. The other points may be found in the reverse direction. It is possible that in attempting to carry this out the increment of current at some point may not be sufficiently great to allow the line by whose length it is represented to bridge over between the two adjacent radial lines; in that case a fresh start must

Fig. 4.

be made a little nearer the centre, making a more acute angle at A (Figs. 5 and 6). The curve for the ordinary D'Arsonval (Fig. 5) and that for the ordinary reflecting galvanometer (Fig. 3), whose readings are given in the Paper already mentioned, lies partly within and partly beyond the usual scale distance, while the curve for a D'Arsonval with magnetic control (Fig. 6) lies wholly within the scale distance. A very small error at the commencement will throw the curve out or in by a very considerable amount, and at

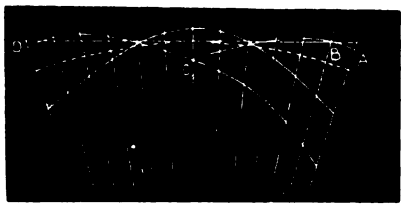


Fig. 5.

first sight this suggests that a serious cumulative error may be produced; but this is not the case, the error is confined to the particular portion in which it was made. Not only is there no danger of a cumulative error on this account, but, provided the zero and the extremity of the scale are each in the correct azimuth, any slight departure from the true curve will produce only an extremely small error in the readings if the curve is tolerably flat.

The use of dividers in taking lengths from a scale is open to several objections; in some engineers' drawing-offices their use is prohibited. The calculation of the increments of current involves subtraction, which is the most tiresome of the rules of arithmetic.

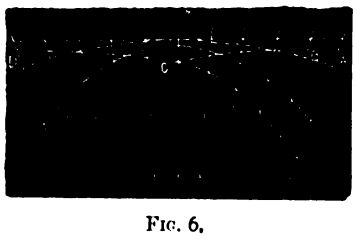


Fig. 6.

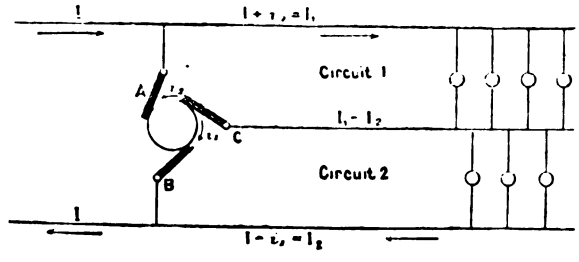
A more continuous method, by which both of these evils are avoided, is furnished by a strip of paper not more than half an inch wide; a piece of Morse ribbon answers perfectly. The current readings are marked on the edge, leaving a few inches over at each end. A fine needle is stuck into the paper at the starting point, and the end of the strip is fastened down with a drawing-pin. The strip, being narrow can easily be twisted through a quarter of a turn, and made to lie flat against the needle, making contact with it at the first current mark. The strip may then be swept round until the next current mark is perpendicular to the corresponding deflection line, and a needle is stuck in to mark the point. The other points may then be found with great rapidity and accuracy.

After crossing the zero line, the curvature generally increases rapidly, and the curve rapidly approaches the mirror. This would generally be open to the objection that the spot of light would get out of focus; but the use of a scale curved to such a shape would often be so convenient that it would be worth while in some cases to work with a parallel beam, or with cylindrical mirrors or lenses, to enable it to be used. For general purposes, where such an innovation as this could not be allowed, a fairly flat scale may be made from the two halves of the curve just described, making an obtuse angle at zero, or at any other point or points near the middle of the scale, as at A C D, Figs. 4, 5, and 6. Such a scale would generally be flat enough to allow the spot to remain in focus. The simplest way to deal with the curve, when found, would be to paste it on a piece of thin board, and cut along it with a band saw. The scale, mounted on card or metal, could then be nipped between the two pieces. There is evidently a connection between the polar curves to which the scale may be thus bent and the Cartesian curve, which shows the relation of the deflection to the current. This relation is not dealt with here, as there does not appear to be any simple geometrical connection between the two. These polar curves could probably be investigated most readily by Whewell's method of intrinsic equations.

THE ELECTRICAL DISTRIBUTION OF ENERGY BY THE THREE-WIRE SYSTEM.*

The advantages of the three-wire system are well known, and the saving of 68 per cent. in copper which was claimed for it has been verified by experience. This point being now admitted and experimentally demonstrated, it is only a question of ascertaining what are the most practical working conditions.

The most important problem in a three-wire system is to divide the current consumption as equally as possible between the two circuits. In many instances, when the three-wire system was first started in America, the inconvenience of having too many lamps alight in one circuit and too few in the other was obviated by taking the three wires into the consumers' premises, and the consumers, by means of special switches, changed their lamps from one circuit to the other as was necessary. As a rule, however, the very elementary precaution of dividing the consumers nearly equally between the two circuits is sufficient for all practical purposes. Let us now consider cases which may arise, distinguishing between a system of mains fed by two dynamos and by one dynamo.



The first case presents no difficulty whatever. The dynamos may be driven either separately or off the same countershafting, according as advantage is or is not taken of a variable cut-off to alter the speed of the dynamo. The only essential is a rheostat inserted in the exciting circuit of each machine. The cross-section of the neutral wire is one-half that of the two outer wires, so that it is possible to have a consumption twice as great on one circuit as on the other. It is evident that the inevitable variations of potential on the line must be remedied by the rheostat in the exciting circuit, but this is not difficult to accomplish. Care must be taken, however, to employ pilot lamps on the leads.

When only one dynamo is employed it is necessary to have recourse to certain special dispositions. The problem has been much studied and has received several solutions. Elihu Thomson employs one large machine, and in parallel with it two small machines, the armatures of which are mounted on the same spindle. The neutral wire is connected to the inner ends of these two armatures, the outer wires of the circuit being joined to the outer ends of the armature coils. If, therefore, one of the circuits is more heavily burdened than the other, the armature of the lighter circuit will be traversed by a current and will act as a motor, driving the machine of the heavily burdened circuit as a dynamo, the E.M.F. of which will compensate for the volts lost on the line. Accumulators may also be used as electric fly-wheels.

In the *Elektrotechnische Zeitschrift* Herr Hermann Müller describes another method. He proposes to employ a small two-pole machine with three brushes, A, B, C (*see* Figure), brushes A and B being

* From *l'Électricien*, February 8, 1890.

Digitized by Google

connected to the two outer wires, and brush C to the neutral wire. When the two circuits are balanced the machine is a motor running light. If the consumption increases on one of the circuits, I_1 becomes greater than I_2, the neutral wire is traversed by a current, $I_1 - I_2$, and a current, i_1, passes through the armature from C to B. The machine then revolves as a motor, and there is a production of mechanical energy, which is transformed into electrical energy in circuit 1. An E.M.F. is generated in A C, which is added to that already existing, and compensates for the extra volts lost on the line owing to the increased current. If we denote the current coming direct from the generator by I, the current passing from C to B by i_1, and that passing from C to A by i_2, we have

$$I_1 = I + i_2;$$
$$I_2 = I - i_1.$$

But the current i_2 produced by the rotation of the armature is sensibly equal to i_1, which causes that rotation. Hence i_1 being equal to i_2, we have

$$I_1 + I_2 = 2 \times I;$$
$$I = \frac{I_1 + I_2}{2}.$$

The tendency of this arrangement is, therefore, to make the total current at any instant the arithmetic mean of the currents in the two circuits. Half the armature always acts as a motor, one of the remaining quarters acting as a motor and the other as a dynamo. The idea is undoubtedly ingenious, but it would be useful to know whether it has been put into practice, and, if so, whether the facts have verified the theory.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *February* 15, 1890.

The United States Government and the Telegraphs.—The subject of the postal telegraph system has, as I anticipated, been brought once more before the public. Postmaster-General Wannamaker, in Washington this week, went before the House Committee on Post Offices and Post Roads, and made a presentation of a scheme to which he gave his full support. It had been understood that the topic would come up, and the Committee had invited to be present Dr. Norvin Green, of the Western Union, and Albert Chandler, President of the Postal Telegraph Company. Neither gentleman appeared, however, and since then Dr. Norvin Green has declined to discuss the matter until he has read a copy of the Bill, and received a full report of the proceedings of the Committee. The Postmaster-General submitted the draft of a Bill which met his views on the subject. The first section establishes the "Limited Post and Telegraph Service" as a bureau of the Post Office department, and directs that all post offices in places where the free delivery system now exists, or may be established, shall be "postal telegraph stations," together with those in any other place where, in the judgment of the Postmaster-General, the wants of the public "may be supplied under the operation of this Act." It is then provided that the Postmaster-General, with the concurrence of the Secretary of the Treasury and of the Attorney-General, may sign certificates for 10 years with any telegraph company for the furnishing of lines or the transmission of dispatches. Dispatches are to be sent in order of filing. They may be prepaid by ordinary stamps if the words "postal telegram" are clearly written upon the blank, and dropped into the letter-box or post office. Money orders are to be sent by wire as soon as arrangements can be made under the proposed law for not more than double the rates now charged for domestic money orders in addition to double the charge for postal telegraphs of 20 words. The amount is limited to $100. For 20 words the charge is to be not over 10 cents to a point within the same State as the office the dispatch is sent from, and not over 25 cents for any distance under 1,300 miles. For greater distances the charge is left to the Postmaster-General's discretion. The amount to be appropriated for establishing this branch of the service is left blank in the draft of the Bill as proposed. When Mr. Wannamaker had finished his argument, and read the provisions of the Bill, he was asked a number of pertinent questions by a member of the Committee. He did not deem it advisable at the present time to establish a rate that would be uniform for messages over the whole of the country; it would be done, however, at some future time, and he was very much impressed with the desirability and feasibility of such a plan. He suggested, with regard to the *employés* at these Postal Telegraph stations, that they could act as operators as well as clerks, and it would be easy for them to learn to telegraph, as the art was now taught in a great many places. These *employés* could be supplied through the agency of the Civil Service Commission. His reason for limiting the duration of the proposed lease to ten years was generally because it was difficult to get capitalists who might desire to aid in developing the system to invest their money for a shorter time. He thought it would be a good thing for the Committees of Congress to fix the rates for messages in the proposed system, so that later the accusation could not be brought against the Postmaster-General that the action in fixing the rates had been arbitrary.

Electrical Execution.—The committee appointed by General Austin Lathrop, superintendent of prisons in this State, to test the efficiency of electrical appliances and dynamos placed in the State prisons for the execution of condemned murderers, has made its report. The gentlemen in question are Drs. MacDonald, Rockwell, and Landy. The report is very voluminous. The questions to be solved were, in the main, whether the apparatus would kill, and what number of volts would be necessary? With the alternating current it was found that about 900 volts was the maximum for horses and other large animals, and about 400 for smaller animals, human beings striking an unhappy average somewhere between. At Auburn a horse and a calf were successfully experimented upon, and the efforts made by Dr. Fell, of Buffalo, by the aid of improved machinery, to resuscitate them, failed entirely, thus proving, the report says, that it was not a case of suspended animation. The main expressions of opinion were that each one of the apparatus proved death could be successfully inflicted and the execution accomplished within four seconds. There is, in the commissioners' opinion, no cause for imagining that there will be any failure of results; but at the same time the committee report that they do not find the apparatus in readiness, and they consider the plants to have been imperfectly set up.

Municipal Lighting.—The question of the trial of lighting plants by municipalities has just come up again out West, in the city of Milwaukee, where the Union Labour party are agitating the subject. It has been claimed out there that the city is paying far too high a price for its light, whether gas or electrical, and it is proposed that the city shall lessen taxation by running its own plant, and thereby getting lights at at least half the rate. I need hardly say that such an idea is highly Utopian, and I might also remark that while a great many of the advocates of the scheme are truly sincere and honest, it does not appear that an overwhelming majority of them contribute to the expense of maintaining the city government. Col. Hinsey, who is the chairman of the City and Country Democratic Committees, expresses himself very sensibly on the subject in an interview. "I do not think it can be done as cheaply as by a private corporation. The great misfortune is that the city pays too much for its labour as compared with private enterprises. There is not a man in the city, county, State, or national employ who does not receive more for his services than he would be likely to get from a corporation. They peg away and try to get one of these situations, and they are no sooner seated than they want a rise of salary. I see this at almost every Session of the City Council. As president of the body, I am chairman of the Committee on Salaries. The *employés* tackle the aldermen and they have a wrestling match with the Committee to comply with the wishes of their constituents. They are all paid too much, comparatively, for the work they perform. Why, I thoroughly believe our waterworks could be run 30 per cent. cheaper by a private corporation for this very reason." This is sound common sense, and involves one of the leading principles of the whole argument against civic monopoly.

Utilising the Niagara Falls.—Once more the proposition to utilise Niagara comes up, but this time it is in more definite and practical shape than it has ever been before. There is a perfected plan, backed by money already subscribed, to utilise

Digitized by Google

the power of Niagara—that is, not the Falls themselves, but of the water head of the river above the Falls. The plan to be carried out is one that I have already outlined in these columns some time ago. It is to be put in force by the Niagara River Hydraulic Tunnel Power and Sewer Company. The idea is to tap the river some distance above the Falls, run a main tunnel with which shall connect 24 cross tunnels, and 12 race-ways, the whole costing in the neighbourhood of about £500,000. The power thus obtained, even if sold at a ridiculously small figure, will pay a good return on the investment. A great deal of it would be used directly in driving factories and mills some distance above the Falls, and the rest would be utilised in lighting and in the long-distance transmission of electricity. In fact, electricity plays a large part in the scheme, and it is whispered around that Mr. Edison will occupy an important position as consulting electrician to the enterprise, which will also be backed at least by one of the strongest houses in Wall-street. The water that is drawn off will not in any material sense lessen the quantity going over the falls. The beauty of the scene will also be preserved from the fact that the factories and manufacturing establishments will be quite remote from the Horseshoe and the American Falls, and that the main tunnel will discharge its waters, like a third fall, some distance below the present town. The place is a good one for manufacturing and for the distribution of goods, and there are, in a word, no difficulties to contend with other than those that can be overcome by the simplest rules of scientific and correct engineering.

The East Reading Electric Railway.—The progress of the electric railways in this country is watched with the greatest interest on all sides, and all the new statistics that are obtainable are scanned with close scrutiny. The report of the East Reading Electric Railway and Motor Company, of East Reading, Pa., for the year 1889, has just been presented, and it brings out some interesting facts. This road was installed a little more than a year ago on the Sprague system, in a location not particularly advantageous; and I may note, by the way, the fact that, so far, it seems to have been one of the predetermined conditions that electric railroads shall be assigned work in situations that are disadvantageous. Be this as it may, the results at Reading have been remarkably gratifying. The number of cars now equipped is four, and the annual report of the treasurer, just issued, shows that dividends at the rate of 8 per cent. per annum on the working capital have been paid, and that a large balance is left in the treasury. The operating expenses during the time were about 2·6 cents per passenger carried. Another interesting fact in connection with this report is that during the year the number of passengers carried was more than double the entire population of the City of Reading. This fact alone shows a popular appreciation that cannot be disputed or denied.

Distribution of Power by Constant Circuit.—In a lecture just delivered by Mr. Elmer A. Sperry before the Chicago Electric Club, the speaker dealt with the problem of long-distance power transmission, and showed how the adoption of high potential for such distribution was an absolute necessity. In discussing the electrical methods to be adopted, Mr. Sperry was very decidedly in favour of distribution by constant-current as against the constant-potential method. He based his argument, first, on the fact that the difference of potential between any two points on the line of a constant-potential circuit was always the same, no matter what amount of power was being transmitted; hence the line was subjected to a maximum insulation strain at all times. On the other hand, with a constant-current distribution, the potential between any two points of the line would vary exactly in accordance with the amount of work being transmitted, and hence at low powers the strain on the insulation would be correspondingly reduced. Again, in support of his argument, Mr. Sperry cited the fact that a constant-current series dynamo for high potential is far cheaper to construct and maintain in good working order than a constant-potential shunt or a compound machine, and hence the advantage in employing the former. It is true an auxiliary dynamo might be employed with a special winding to excite the field magnets of the shunt machine, but this would involve additional complication. On the subject of regulating a constant-current motor, Mr. Sperry was of the opinion that there ought to be no difficulty in designing a mechanical governor which should be able to maintain the speed of constant-current motors within one or two per cent. for all loads—that is, equal to the performance of constant-potential machines at the present day.

PARIS NOTES.

(FROM OUR OWN CORRESPONDENT.)

February 25, 1890.

In my last letter I gave some particulars with regard to the system of distribution affected by M. Victor Popp, and I cannot do better this week than describe the Solignac system which it is proposed to work side by side with that of M. Popp. The ideas underlying M. Solignac's patents may be briefly stated as follows. It is not possible in practice to run alternators in parallel; on the contrary, it is easier to run high potential continuous-current machines in this way. On the other hand, continuous-current transformers have not up to the present been much employed, while alternate-current transformers have. Hence the system to be used is one in which high-tension continuous currents are rendered alternating, thus making it possible to use alternate-current transformers. The theory of M. Solignac seems to me somewhat defective, inasmuch as we have had as yet no example of high-tension continuous-current dynamos working in parallel, and because the conversion of the continuous current into an alternating one will certainly be accompanied by considerable loss. The apparatus with which it is proposed to effect this transformation is simply a rotating commutator introducing varying resistances into the primary circuit of an ordinary transformer placed across the mains, the coils of which are therefore traversed by a pulsating current. To prevent the commutator from being quickly destroyed, an air blast similar to that used by the Thomson-Houston Company is brought into play. The Solignac system was to be seen at work at the Exhibition supplying Jablochkoff candles. The purchase by the Popp Company of the Gaulard-Gibbs patents for France has, doubtless, something to do with their adoption of this wonderful alternate current system, which is worth noticing owing to the fact that there is some likelihood of its being actually worked in the district allotted to the Popp Company. Meanwhile M. Popp has received financial support from Berlin to the amount of over a million sterling, and proposes to erect a 20,000 horse-power generating station.

Last week there came on for hearing the action brought against the State by the Société Générale des Téléphones for the purpose of vindicating the validity of the agreement of July, 1886, between the Société and the Government. After hearing the arguments on either side the Court announced that judgment would be delivered in a week's time.

BRUSSELS NOTES.

(FROM OUR OWN CORRESPONDENT.)

BRUSSELS, *February* 21, 1890.

Since my last letter the only event of note has been two concluding debates at the Société Belge des Ingénieurs on the question of the electric lighting of the city. At the first of these debates M. Lucien Anspach combatted at one and the same time the hydro-electric scheme of M. Van Rysselberghe and the low-tension proposals of M. Bède, advocating continuous-current distribution at 2,000 volts pressure. Perhaps the most important outcome of the discussion was the decision to appoint a Technical Commission to examine M. Van Rysselberghe's turbine. At the second and final meeting M. Bède explained the Popp compressed air system at considerable length, and this series of conferences came to an end with an expression of confidence in the competence and patriotism of the Conseil Communal.

BOOKS, &c., RECEIVED.

"Die Elektrotechnik in ihrer Anwendung auf das Bauwesen.' By H. Görges and K. Zickler. (Leipzig: Wilhelm Engelmann.)

"Instructions for Fixing and Working Dynamo-Electric Machines." By W. C. Mountain. (Newcastle-on-Tyne: Ernest Scott and Co.)

"Laxton's Price Book for 1890." (London: Kelly and Co.)

Digitized by Google

CORRESPONDENCE.

LIFE AND EFFICIENCY OF GLOW LAMPS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: There is such an interdependence between the life and efficiency of a glow lamp, that it is high time that one of these words should never be spoken of without the other; and for this purpose I think it would be most convenient if a standard efficiency (say 3½ watts per candle-power) were adopted for general use or as a reference, and that all lamps should be compared for life or durability at this standard efficiency.

The separate use of the above terms (life and efficiency) is a very attractive method of making misleading and utterly useless statements, which one daily meets with in technical and other papers. What value, for instance, have the following recent extracts beyond their misleading value?

In one of your contemporaries I read a note headed "Life of Incandescent Lamps." A certain 100 volt 16 candle-power Edison-Swan lamp is stated by Sir D. Solomons to have run for over 3,400 hours; but such a statement must be known to be useless without stating how many watts were required to produce the actual, or, at the very least, the nominal candle-power. Again, in *The Electrician* of the 14th inst. there appears an advertisement *re* Coad's battery. A report is given (in copy) stating "the cost per twelve hours of production of light," &c. Even supposing the word light to mean a light of one candle-power, then the omitting to say what number of watts this one candle-power requires leaves us to guess how much it would cost us for lamp renewals. Again, in the same number of *The Electrician* appears a note entitled "Mr. Edison and his Work," reprinted from *Harper's Magazine*. We are told that Mr. Edison has constructed "3,000 reasonable theories in connection with the electric light," &c., and "that Mr. Edison has now reached a point where he could maintain fully fifteen lamps to the horse-power;" but we are not told which of 3,000 equally reasonable theories we are to adopt respecting the life or duration of these same fifteen lamps.

I give below a test taken from an old note book of mine of 1883, which will show what can be asserted without a simultaneous use of the words life and efficiency:—

Candle-Power.	Watts per C.P.	Candles per E.H.P.	Notes.
10	3·08	242	Normal
15	2·63	...	...
20	1·97	...	...
25	1·66	...	...
30	1·48	...	...
35	1·36	...	...
40	1·25	...	...
50	1·05	710	...
60	0·92	...	...
70	0·83	...	...
80	0·75	...	...
100	0·63	...	...
200	0·41	...	...
300	0·28	...	...
400	0·21	3,552	Was not broken after running for 2 hours at same E.M.F.*

* Quite a sufficient time to show off the merits (?) of any battery.

A 50 volt 10 candle-power (normal) filament was mounted on extra thick platinum with extra heavy mounts, and gave the results set out.—Yours, &c.,

C. J. ROBERTSON, A.I.E.E.

Middelburg, Holland, February 19, 1890.

TELEPHONES FOR DOMESTIC USE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Without wishing to detract from Mr. A. A. Campbell Swinton any credit for originality in his arrangement of automatic switch, as defined in your issue of this date, I would ask permission to state that the method he uses, and patented in 1887, was anticipated in 1883 (No. 2,592) by Colonel G. E. Gouraud, who was then connected with this Company.

Our invention, which you kindly described in your issue of the 14th instant, is absolutely novel, inasmuch as in both the patent of Gouraud, 1883, and in that of Swinton, 1887, "the call" can *only* be made "when the telephone is off the hook." This is not so with ours, and moreover, sundry other conveniences occur in our invention that are absent in the others. For these details I would, with all respect, refer your readers to the usual Blue Book (Patent No. 5,867, 1889).—Yours, &c.,

W. J. M. MENZIES.

No. 109, Farringdon-road, London, E.C.,
February 21, 1890.

CARRARA ELECTRIC LIGHT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Surely there must be some mistake about the paragraph under this head in yesterday's *Electrician*.

It is said that 350 16 candle-power lamps and 25 arcs are to be supplied by using a waterfall of 27 gallons a *minute* falling 260ft. I suppose this number of lights would at a moderate computation require 75 horse-power. Now, the gross horse-power of the waterfall is only $\frac{27 \times 10 \times 260}{33{,}000} = 2{\cdot}13$ horse-power. Allowing the turbines an efficiency of 75 per cent., this gives a net horse-power of about 1·6. Perhaps for *minute* we should read *second*. This would give $1{\cdot}6 \times 60 = 96$ horse-power, which may be what is really required, unless the engineers adopt a wonderful American water machine, which the agent assured me delivered 10 horse-power for every one horse-power put into it. I suggested that this should pump water to work a second engine, which would convert the 10 horse-power into 100 horse-power, and so on, until I showed him that an engine of 1 mouse-power could, by this "series system" drive the "City of Rome" through the Atlantic As I would not believe the agent's assurances, he told a friend of mine that I was "the cussedest conservative he ever 'lighted on," and so I remain—Yours, &c.,

72, South-mall, Cork, February 22, 1890. DENNY LANE.

[The alteration suggested by our correspondent is probably the correct one, and we regret the figures were inserted without being tested for accuracy.—ED. *E.*]

THE ETHER THEORY OF 1839.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I sent Dr. Lodge a copy of the first part of my book entitled "The Ether Theory of 1839 is the True Theory of the Leyden Jar." Having received from him a letter, which I saw might do good if published, in that it would give editors and others freedom to write without bias on the subject, I requested Dr. Lodge's permission to publish it, and, as he has consented, I send you a copy.—Yours, &c., JAMES JOHNSTONE.

8, Merchiston Park, Edinburgh, February 20, 1890.

[COPY.]

"21, Waverley-road, Liverpool,
"February 15, 1890.

"To James Johnstone, Esq.,

"Dear Sir: I am indebted to you for a pamphlet in which you subject my little book, "Modern Views," to a criticism which cannot but be wholesome.

"It depends on what is meant by 'electricity passing through glass.' In a sense it certainly does, but not by conduction. I expect you have got hold of a true idea in connection with the matter.—Yours truly,

(Signed) "OLIVER J. LODGE."

LEGAL INTELLIGENCE.

Chatenay v. Brazilian Submarine Telegraph Company.

This case came before Justices Denman and Vaughan Williams, in the Divisional Court of the Queen's Bench Division of the High Court of Justice on Friday last, by way of an application by the plaintiff to vary an order made by Baron Pollock in chambers.

Mr. H. D. GREENE, who, with Mr. Alexander Young, appeared for the plaintiff, said the issue to be tried had been directed by the court under the following circumstances:—Mr. Chatenay, who resided in Brazil, was on the

Digitized by Google

register of shareholders of the defendant company, and, finding that his name had been removed therefrom, he applied under Section 25 of the Companies Act, 1862, to have it restored, because he contended that his name had been removed without lawful or just cause. Thereupon the Court ordered that an issue should be tried, whether the plaintiff's name had or had not been improperly removed, and this issue was now waiting trial before a jury. The defendant company, in answer to the plaintiff's complaint as to having taken his name off the list of shareholders, said that he (the plaintiff) having given a power of attorney to a gentleman in London, they (the company), acting on that power, had transferred the shares out of the plaintiff's name. The defendants contended that Brazilian law, and not English law, would govern the construction of the power of attorney, and, that being so, it gave a general power to the holder to act in the way he had done. Mr. Chatenay, on the other hand, said the power of attorney must be read according to the law of England, and, so reading it, it was clearly a limited power, and did not authorise what had been done. In August last the defendants applied to the Master for a commission to go out to Brazil to examine witnesses as to how the authority would be determined by the Brazilian Courts. The Master refused this application, holding that it was entirely a matter for the English Courts. Thereupon the defendants appealed to Baron Pollock, who referred the matter for the decision of the judge at the trial of the issue.

Mr. FINLAY, Q.C. (with him Mr. W. GRAHAM), represented the defendants. He said if all that the plaintiff wanted was to have the question of whether the Brazilian law or the English law governed the matter tried as a preliminary question before a judge without a jury, he should not object.

Mr. GREENE acquiescing in this, their Lordships ordered the question to be tried before a judge.

In re JAMES FYFE.—The statement of affairs under the failure of James Fyfe, described as of St. Stephen's Chambers, Telegraph-street, City, has been issued. The debtor states that he is an electrician, and that for two years prior to May, 1884, he acted as managing director to an electric light company in which he had a large interest. He attributes his insolvency to his inability to realise certain property without resorting to litigation, which he considers would be necessary to establish his claims. The receiving order was made in December last, and the statement of affairs now furnished shows gross liabilities £18,707, of which £17,408 are fully secured, and assets of uncertain value. The securities held by creditors, treated as fully secured, are stated to consist of shares in electric light companies (estimated at £4,336) and patents for electric lighting (£14,000). The bankrupt considers that a surplus of £927 might be realised on some of the shares.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning.*]

"THE ELECTRICIAN"

ELECTRICAL TRADES' DIRECTORY & HANDBOOK for 1890

The new edition of our well-known Directory and Handbook is now ready. The book consists of 850 pages, and has entailed this year an exceptionally heavy amount of work. The HANDBOOK DIVISION contains a mass of most useful information. The DIRECTORY DIVISION consists of more than 400 pages, and contains a very carefully compiled Alphabetical and Classified List of Firms and Persons engaged in the Electrical and Allied Trades in all parts of the world. This Division has been corrected up to date, and the book is thoroughly reliable, even the very numerous changes which take place in the month of January being incorporated. The book is not a mere list of Members of Scientific Societies repeated again and again. The Colonial and Foreign Division will be found extensive and reliable. The book has been very favourably reviewed by the Press. *Orders should be forwarded at once.*

TENDERS INVITED.—The Director of Army Contracts invites tenders for the purchase of scrap iron, steel, &c., for one year, from April 1st next. Tenders must reach the War Office, Pall Mall, London, S.W., by 12 o'clock on Friday, March 14th.

MESSRS. BLENHEIM AND CO.—This company have recently received an order to fix their improved system of street fire alarm telegraphs for the district of the Local Board of South Hornsey, and also an order to re-wire the telephone exchange and electric bell system at the St. Saviour's Union, Dulwich.

BLAMIRE'S PATENT INDICATING APPARATUS.—We have received a circular describing this invention, which is "to enable masters, managers, or foremen to ascertain at any time or place whether any machinery, engines, or tools are standing or are in motion, and doing their proper work." This operation is performed by a special arrangement of electrical communication. It is claimed by the inventors that for the application of this apparatus any existing telegraph, telephone, or other established electrical circuits can conveniently be adapted without interfering with other instruments.

SALES BY AUCTION.—Our readers are reminded that Mr. Alfred V. Robinson will offer for sale at the Mart, Tokenhouse-yard, E.C., on Tuesday next, at two o'clock, the valuable leasehold electrical manufacturing premises at Pownall-road, Haggerston, London, N.E. Further particulars will be found on page III. of our advertisements.

——— Some valuable freehold property, suitable for manufacturing electricians, electrical engineers, &c., situate at Dalston, N.E., will be offered for sale on Tuesday, March 11th, by Messrs. Thurgood and Martin, of Chancery-lane, E.C.

PERSONAL.—Mr. R. Lewis Cousens sails for South Africa in a few days to represent Woodhouse and Rawson United (Limited), in South Africa. The firm intend to keep at their new offices in Johannesburg a large stock of electrical machinery and accessories.

BUSINESS TRANSFER.—We are informed that Messrs. Pontifex and Wood (Limited), the well-known ironfounders, engineers, and coppersmiths, of the Farringdon Works, Shoe-lane, E.C., have transferred their Millwall metallurgical works and white lead business to the Millwall Lead Company (Limited), of 17, Philpot-lane, E.C., and Millwall. In future the only address of Messrs. Pontifex and Wood (Limited) will be the Farringdon Works, Shoe-lane, E.C., where the engineering business will be carried on as usual.

THE THOMSON-HOUSTON ELECTRIC MOTOR.—We have received from the Thomson-Houston Motor Company of America, a handsomely got-up pamphlet, describing the mechanical design, regulation, rheostat, tests, and classification of the Thomson-Houston motor. Illustrated descriptions are given of the application of the motor to mills, tramways, printing machines, electric hoists, mining, mining locomotives, drawbridges, shoemaking machines, and general tramway work. The brochure contains a number of full-page illustrations, showing the motor at work in printing offices, harness and saddlery warehouse, shoemaking shops, &c., and illustrated details of the construction of the machine are also given.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

January 30, 1890.

1,629. A. J. BOULT. London. Improvements in or relating to electric accumulators (G. G. A. Giovanni, Italy).

1,638. H. M. HARCOURT. London. Electric automatic railway alarm and signalling device and apparatus.

1,644. A. L. LINEFF. London. Improvements relating to electric traction.

1,646. P. C. BREWSTER. London. Improvements in safety devices for electric lines.

1,658. C. P. ELIESON. London. Improvements in and connected with electricity meters.

February 1, 1890.

1,768. J. SAX and E. DONOHOE. London. Improvements in apparatus for electrically indicating or recording the number of times that a closet lavatory or the like is used.

February 3, 1890.

1,734. T. A. GARRETT. London. Improvements in and connected with the production of ozone by means of electricity.

1,822. J. LEE. London. Improvements in electrically-actuated whistles, trumpets, and horns, and in speaking tubes for domestic and business use, for hotels, for train intercommunication, and other purposes.

SPECIFICATIONS PUBLISHED.

1889.

3,365. KAMM. Electrical conductors. (Price 8d.)

4,235. CONTE. Coin-freed dynamo-metric apparatus. (Price 8d.)

4,566. PREECE and SAYERS. Electrically lighting trains. (Price 8d.)

4,998. BOURON. Magneto-electric machines. (Price 8d.)

5,063. HUNGERBÜHLER and TODMAN. Measuring electric currents, &c. (Price 8d.)

5,291. ZIPERNOWSKY and others. Current motors. (Price 8d.)

5,423. KING. Conduits for electric conductors. (Price 6d.)

THE NORTHERN ELECTRIC WIRE AND CABLE MANUFACTURING COMPANY (LIMITED).—The first annual meeting of this Company was held at the Company's offices, Square-road, Halifax, on the 18th inst. The Directors report a rapidly increasing business, and congratulate the shareholders on the good prospects before the Company. After stating that the profits are over 10 per cent. for the year, the Directors recommend a dividend of 7½ per cent., placing the balance to a reserve fund, which was agreed to, and after the usual vote of thanks the meeting closed.

Digitized by Google

COMPANIES' MEETINGS & REPORTS.

The Notting Hill Electric Lighting Company (Limited).

The ordinary and extraordinary general meetings of this Company were held on Tuesday last, at the offices of the Company, 9, Austinfriars, London, E.C., Mr. William Crookes, F.R.S., the Chairman, presiding.

The SECRETARY (Mr. W. H. Fox) read the notice convening the meeting and the minutes of the extraordinary general meeting of November 27, 1889, which were confirmed and signed by the Chairman.

The CHAIRMAN: Gentlemen, there is no special business before the meeting, but the Directors thought that as soon as possible after the general allotment, the shareholders should be asked to come together to receive information as to the state of affairs, and have the opportunity of asking any questions they might like to put to us. I may as well give a short history of the Company. The date of the registration was just about two years ago—in February, 1888; and the statutory general meeting was held on June 6, 1888. The second general meeting was held on the 3rd October, 1889. The Act of Parliament obtained the Royal assent on August 26, 1889, and this Act gives the Company a practical monopoly over the whole of the area which is assigned to us. You had with the prospectus a small lithograph, showing the area given, and behind you is a large map, 5ft. to the mile, on which the area is outlined, showing all the streets existing up to the present date. The Directors of the Company, who for nearly two years were the only shareholders, gave a very great deal of time and trouble to the matter, for we had about fifty board meetings, and besides that there was a very great number of informal meetings at the houses of the different Directors, and meetings at the vestry late at night and early in the morning: meetings before the Board of Trade; meetings at Major Marindin's Committee, where some of us had to be in attendance the whole time, and meetings in obtaining the Provisional Order before Parliament. Of course, up to the time of going to allotment the expenses of all this, which amounted to about £1,500, were paid out of funds which the Directors themselves supplied. The results of the recent application to the public are these:—We have got about £70,000 subscribed, and that the Board consider is quite sufficient to carry out the whole of the lighting of this large district in the terms of the Act. This has enabled us to apply for a special settlement and quotation on the Stock Exchange, and it is hoped that that quotation will be granted. The Secretary of the Stock Exchange has suggested that we should alter one of the Articles, and the extraordinary general meeting to-day is called for the purpose of altering that Article. Since we were able to see that a certain amount of money was likely to be at our disposal, we have been very busy in pushing forward the subject of getting estimates, which was necessarily going on rather slackly before. All the preliminaries were well advanced; and now we have estimates from different firms for supplying the machinery. I believe, in the prospectus, it was stated that we had only a lease of the land for the central station; but we have now purchased the freehold at an additional expense of £1,350, and on the map the red dot shows where the central station will be. It is very centrally situated for the greater part—over one-half of the district—and occupies, I think, about as good a position as we could possibly get at the price, and is almost the only position available. The amount of capital called up is £14,800. There is a sum of money on deposit at present, which is earning more than sufficient to pay the current office expenses, but I am afraid we shall soon have to take it out of deposit, because the expenses now are of course running on, and we shall have to pay for the machinery. The contracts entered into amount to about £24,000, but we shall not have to pay the whole of them at once—that will run over the rest of this year. We have plenty of cash in hand, therefore, for the present, and if a call is necessary later on it is expected that there will not be required more than £2. 10s. up to the end of the year. The land will cost about £6,000: the machinery will be about £7,000; the building about £4,000; and putting down the mains in certain streets, which we consider it advisable to take first, will cost about £7,000, making a total of £24,000, which will have to be paid during the present year. In the prospectus it was stated that the preliminary cost would not exceed £4,000, and a statement which has just been made to us by the secretary shows that the original cost is slightly under that amount. With regard to mains, of course a great part of our area consists of very good highly-rented residential houses, from which we may reasonably expect to get good customers. A smaller portion of them, especially near the outlying districts, consists of rather poorer houses, and it is not likely we shall have a great many customers from among them, so it has been decided to divide the area into about three parts. The first is represented on the tracing before you, which is on the same scale as the ordnance map. The tracing shows the mains we are going to lay down first, at an expenditure of about £7,000. This includes nearly the whole northern part of the parish, and comprises the greater part of the compulsory area in that portion of the district. As soon as we have got fairly on the way with that, we shall attack the rest of the compulsory area mentioned in the Order, including all the streets that we are obliged to light within two years; and we are in hopes, if things go on well, we shall have the second lot of mains in an advanced state by the end of the year. I do not like to prophesy until a thing has happened, but, judging from the results obtained in a neighbouring electric light district, from which we have derived a great deal of experience—we have got the benefit of their experience and the results of the unavoidable little mistakes and errors which are always made in starting a new thing—to judge from the results that have taken place in that district, with a class of houses very similar to a good many of the houses that we should have, it is found that between 30 and 35 houses will pay expenses. I think that we can see our way certainly to between 50 to 100 houses to start with. We have definite orders for a great many, and I know personal friends of my own in the district, and friends of the Directors, who, as soon as the mains come near the houses, will have their houses wired; so that I think there is no doubt whatever that very soon we shall get over the magic number thirty, which will clear working expenses, when the rest will be bringing in profit. Then it is shown that the first 200 houses brought in £3,000 a year profit; and the first 400 produced £7,000 profit. We have over 4,000 houses in our district, so I think before the end of the year we shall be getting a certain amount of revenue, and I hope securing a very nice profit. The engineer for an adjoining company, the Kensington and Knightsbridge Company, is also our own consulting engineer—I mean Mr. Crompton. He has had, I think without exception, the largest experience of anyone in the world in laying down mains and lighting large districts from a central station. He has tried many plans for laying down mains, and has at last come to the very definite conclusion that a certain plan which is being adopted in the Kensington and Knightsbridge district, and a great many other places in England, is, without exception, the best as well as the cheapest and safest method of laying mains. He has given us full plans and details of the method of doing it, and the subject is before the Directors now as to how far we shall adopt the plans he has recommended. I do not think there is anything else to say now, but, of course, there may be several questions which shareholders would like to ask, therefore I will conclude by saying that we shall be very happy indeed to give every information possible. We want to give the shareholders every possible information that they can require, for I do not agree with keeping anything dark in a matter like this. The oftener we meet the shareholders and consult with them, and the more fully we tell them exactly what we are going to do, the better it will be for the general work and for everyone concerned. I may add that the next general meeting is proposed to be held in about twelve months' time—on the last Tuesday in February, when the accounts up to December 31st this year will have to be considered. But, of course, as soon as the works are opened—which we hope will be some time within the next six or eight

PATENT
SILICIUM BRONZE AND SILICIUM COPPER WIRE.
The best for overhead Telephone and Telegraph Lines,
AND ALL ELECTRICAL PURPOSES.
Hard Drawn High Conductivity Copper Wire.
ROLLED AND DRAWN
PHOSPHOR BRONZE.
PHOSPHOR BRONZE
VULCAN PHOSPHOR DURO METAL
PHOSPHOR BRONZE
BEARINGS, BUSHES,
AND OTHER PARTS OF
ELECTRICAL MACHINERY.
SOLE PROPRIETORS of the British, Indian and Colonial Patents,
THE PHOSPHOR BRONZE COMPANY (Limited),
87, Sumner Street, Southwark, London, S.E.
WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

Digitized by Google

months—we propose to call an extraordinary meeting, and probably we should invite the shareholders to come and view our works. Estimates certainly vary, but I think before the dark days come again we shall have the works open, and the light laid on to a great many houses. That, gentlemen, concludes the business of the general meeting.

The extraordinary general meeting was then called, and the Secretary having read the notice convening it,

The CHAIRMAN said: As I mentioned just now, this is a matter of pure form, to comply with certain requirements of the Stock Exchange. Therefore, if no gentleman has anything to say on the subject, I will propose that the resolution as follows be adopted:—

"*That Article 59 of the Articles of Association of the Company be altered by omitting the following words therefrom, namely:—'Relating to the increase of capital of the Company, the setting aside a reserve fund to meet depreciations of the property of the Company, or any part thereof or concerning or'—such words commencing in the third and ending in the sixth line of such Article.*"

Mr. WATERS seconded the motion, which was carried unanimously.

The CHAIRMAN: We will send round the notice of the confirmatory meeting which is necessary, and that concludes the whole of the business before us. Gentlemen, we must thank you for your attendance to-day.

Mr. ROMER: I beg to propose a vote of thanks to our Chairman for the very explicit information he has given us as to the progress of the works.

Mr. WEST seconded this, and it was carried by acclamation.

The CHAIRMAN having replied, the proceedings terminated.

Telegraph Construction and Maintenance Company (Limited).

The following is the report of the Directors to be submitted to the members at the twenty-sixth ordinary meeting to be held at the offices of the Company, 38, Old Broad-street, E.C., on Tuesday, March 4th, at one o'clock.

The Directors feel that their first duty at this meeting is to express their deep regret at the loss the Company has sustained in the death of their late Chairman, Sir Daniel Gooch, Bart., which feeling they do not doubt will be shared by the proprietors generally, and they desire to lay before them the copy of a resolution which was passed at the Board meeting of October 23, 1889, being the first held after that melancholy event:—"That on the death of their Chairman, Sir Daniel Gooch, which occurred on the 15th instant, the Board of Directors desire to place upon record their high sense of the services rendered by him to the Company during a period extending over 25 years, for 21 of which he was the Chairman, and at the same time to give expression to their own feelings of sincere regret at the loss of an able and upright colleague, for whom they always entertained the highest respect and esteem."

At the same meeting Sir George Elliot, Bart., who has been a member of the Board since the formation of the Company, was unanimously requested to accept the position of its Chairman, and was duly elected. Mr. James Pender has been elected a Director of the Company to fill the vacancy caused by the death of Sir Daniel Gooch.

The accounts for the year show a net profit of £83,746. 12s. 11d., after charging the interest on the Debentures. To this sum must be added £43,376. 14s. 4d. brought forward from last year, making a total of £127,123. 7s. 3d. From this amount is deducted the interim dividend of 5 per cent., paid July 16, 1889, amounting to £22,410, leaving £104,713 7s. 3d. to be dealt with. Of this sum the Directors propose to distribute a dividend of £1. 16s. per share, absorbing £67,230, being at the rate of 15 per cent., and making, with the amount already paid, a total dividend for the year of £2. 8s. per share, or 20 per cent., free of income-tax, leaving £37,483. 7s. 3d. to be carried forward to the next account.

During the past year, the cable factories at East Greenwich and at Wharf-road have been fairly occupied, and the increase in the general business at the latter works shows a marked improvement; a length of about 4,800 miles of telegraph wire has been insulated for submarine cables and land lines.

The Company's steamships have laid cables between the Cape of Good Hope and the Port of Mossamedes, on the western coast of Africa, thus completing the circuit of that Continent; between Java and Western Australia, thus triplicating the Eastern Extension Telegraph Company's lines to Australia; and between Monte Video and Chuy River, on the coast of Uruguay, for the Western and Brazilian Telegraph Company.

Various repairs have also been carried out during the year, on and near the banks of Newfoundland, for the Direct United States and the Anglo-American Telegraph Companies.

The charter of the ss. "Calabria" continued throughout the year, but has since terminated.

The Company's factories at East Greenwich and at Wharf-road are in efficient working order.

The retiring Directors are Sir Thomas Fairbairn, Bart., and Mr. James Pender, who, being eligible, offer themselves for re-election.

The meeting will have to appoint auditors for the ensuing year. Mr. John Gane (Messrs. Gane, Jackson, and Jefferys) who retires, offers himself for re-election. Mr. James Glegg (Messrs. Welton, Jones, and Co.) does not seek re-election. Mr. Patrick Glegg, a member of the same firm, who has always assisted Mr. James Glegg in his audit of the Company's accounts, will offer himself to the shareholders for election.

NEW COMPANIES REGISTERED.

POOLE AND WHITE.—Registered to carry on the business of electric lighting and the supply of appliances in connection with the business and electricity generally, adopting therefor an agreement to be made with Messrs. Poole and White, of Bread-street, Cheapside, for the purchase and taking over of the goodwill, assets, and liabilities of their business upon terms the particulars of which are not specified in the articles of association. Capital, £20,000 in £5 shares. T. G. Poole to be secretary to the company. Borrowing powers not restricted. Registered February 18th, by Saltwell and Tryon, solicitors, 1, Stone-buildings.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended February 21st amounted to £4,637.

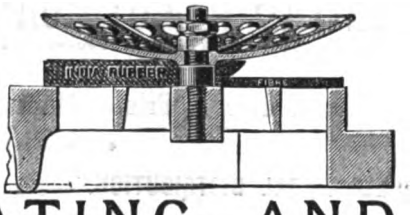
THE MAXIM-WESTON ELECTRIC COMPANY.—Some correspondence has recently appeared in a financial contemporary respecting the position of this Company, to which Mr. T. Blades Gooding has replied as follows:—"In reply to various letters which have from time to time appeared in the London financial papers, calculated to prejudice the interests of this company, I beg to say that the Directors who have retired have not done so because the resources of the Company are exhausted, nor can our resources be truthfully thus described. I do not propose to discuss, in the public press, the financial position of the Company: there will be a shareholders' meeting shortly, at which grievances may be aired and discussed. The Directors have discontinued salaries and fees amounting to nearly £1,000 per annum, and they have now several travellers—responsible men—soliciting orders where not long since they had none. Mr. Swaby now holds no official position in the Company, and has resigned his seat at the Board, which now comprises Mr. John Marks, Mr. Couchman (original Directors), and myself. Mr. Hamilton has resigned the secretarial duties, which are now satisfactorily performed, with no addition to the clerical staff, by Mr. R. Barley. The Board unanimously agreed not to participate in the fees of the retiring Directors, and draw for fees less than one-third of the sum to which they are entitled under the Articles of Association. The Company has established a central station at Dalston, and is now engaged in the manufacture of switches and other electrical appliances, and we hope to largely develop this branch of the business and compete with all other manufacturers for the supply of the whole London and provincial trade. St. Margaret's Mansions are being wired and lighted from our own machinery, and other jobs, too numerous to particularise here, are in hand."

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY (LIMITED).—Notice is given that the transfer books of this Company will be closed from the 24th inst. to the 4th prox., both days inclusive, preparatory to the payment of dividend to all shareholders on the register on the 24th inst.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended February 21st, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,523.

NEW VALVE

No Rubber, Percha, or Leather.



One-half the price of Rubber or Metal.

FOR CIRCULATING AND AIR PUMPS.

Unaffected by any Lubricating Oils. Does not Expand in diameter. Feed Water may be worked at any temperature Suitable for any shaped guards. Only one quality manufactured.

"12, John-street, Sunderland, 26th Sept. 1885.

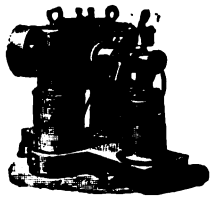
"DEAR SIRS,—In reply to your letter of the 25th inst., the Valves I got from you have done their work well, and ARE AN UNQUALIFIED SUCCESS. I will continue to get them from you as required.—Yours faithfully, JAMES WESTOLL."

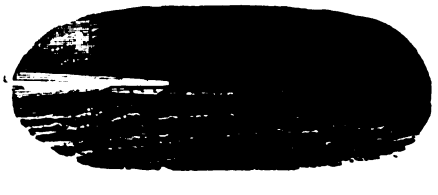
For further Testimony and Prices, apply to MOSSES & MITCHELL, 68-71, Chiswell Street, London.

Digitized by Google

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Wednesday, Feb. 26, 1890.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending Feb. 26, 1890.	
£			**TELEGRAPHS.**		£ s. d.		Highest.	Lowest.
1,770,360	Stock	12/6	Anglo-American	49 50	5 10 0	Jan., Apr., July, Oct.	49	...
2,614,820	Stock	25/0	Do. Preferred	82½ 83⅝	6 11 9	,, ,,	85⅜	82½
2,614,820	Stock	...	Do. Deferred	14 14½	...	February	15⅛	14⅛
130,000	£10	3/0	Brazilian Submarine	12½ 12⅝	5 17 8	Mar., June, Oct., Dec.	12⅜	12⅜
112,900	£100	5%	Do. 5 per Cent. Bonds	103 102	4 18 0	January and July	100½	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	104 107	4 13 6	June and December.	...	...
16,000	10	9/0	Cuba Submarine	11½ 12½	7 4 0	February and August	11½	...
6,000	10	10%	Do. Preference 10%	19 20	5 0 0	,, ,,	...	...
12,931	5	2/0	Direct Spanish (£4 paid)	4 4½	4 8 11	March & September	...	...
6,000	5	10%	Do. Preference 10%	9 10	5 0 0	April and October	...	...
60,710	20	3/6	Direct United States	9⅞ 10⅛	6 18 3	Jan., Apr., July, Oct.	10⅜	10⅛
380,000	10	2/6	Eastern	13⅝ 14⅛	4 12 0	,, ,,	14⅛	13⅜
70,000	10	6%	Do. 6 per Cent. Preference	14⅛ 15⅛	3 18 8	,, ,,	...	...
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock	105 107	3 14 9	May and November.	105½	...
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	106 109	4 11 9	February & August	...	...
250,000	10	2/6	Eastern Extension	13⅜ 14	4 12 10	Jan., Apr., July, Oct.	14	13⅛
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	100 102	5 17 8	February & August	...	...
473,000	100	5%	Do. 5 per Ct. (Austrln. Gov. Sub.) Debs. 1900	102 105	4 15 3	January and July	...	...
179,177	10	1/9	Globe Telegraph and Trust	8⅝ 8⅞	5 15 6	Jan., Apr., July, Oct.	8⅛	8⅛
178,992	10	6%	Do. 6 per Cent. Preference	14⅜ 14⅝	4 2 1	,, ,,	14⅜	14⅜
150,000	10	5/0	Great Northern	15¼ 15⅜	4 15 3	Jan., July, and April	15⅛	15⅝
17,000	25	12/6	Indo-European	41 43	5 16 3	April and October	41½	41
9,000	8	4/0	Reuter's	7 7½	5 6 5	April and October	...	...
15,609	10	3/6	West African Telegraph	9½ 10½	...	...	...	...
300,000	100	5%	Do. 5 per Cent. Debentures	99 102	4 18 0	March & September	101½	100½
30,000	10	5/0	West Coast of America	10½ 11	4 10 11	January and July	...	...
150,000	100	8%	Do. Debentures 8%	119 124	6 9 1	June and December	...	...
88,321	10	nil.	West India and Panama	3¼ 3½	...	...	3⅜	3⅛
34,563	10	12/0	Do. 1st Preference 6%	11¾ 12¼	...	April and October	11⅛	...
4,669	10	10/0	Do. 6 per Cent. 2nd Preference	15 16	3 15 0	...	15½	...
45,181	15	6/0	Western Brazilian	10⅛ 11	...	May & November	10⅜	10⅛
£1,500	£1,000	7%	Western Union 7 per Cent. 1st Mortgage	118 122	5 14 9	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	102 104	5 15 5	March & September	...	...
			TELEPHONES.					
224,350	14/0	5%	Consolidated Telephone and Maintenance	1⅛ 1⅛	...	Yearly	...	...
220,000	£1	3%	Oriental (11s. paid)	1/16 1/16	3 5 11	...	...	...
80,000	5	6%	National	4⅞ 5⅛	...	June and December.	5⅛	5
55,000	5	3/0	United River Plate	4¾ 5¼	...	January and July	5 1/16	4⅞
			ELECTRIC LIGHT.					
500,000	10	...	Metropolitan Electric Supply (£5 paid)	4⅝ 4⅞	...	...	4⅞	4⅝
79,934	5	6%	Swan United (£3. 10s. paid)	5¼ 5⅜	3 13 0	...	5⅜	5⅛
			MISCELLANEOUS.					
87,350	12	12/0	Telegraph Construction and Maintenance	45 47	5 2 3	March and July	46½	45½
41,600	10	10/0	India Rubber, Gutta Percha & Telegraph Works	18½ 19½	5 2 7	February & August	18¾	18¾





Before Ordering!

ELECTRICAL PLANT & ACCESSORIES

WRITE FOR THE FOLLOWING PAMPHLETS TO THE

UNITED ELECTRICAL ENGINEERING CO., Ltd.

Head Offices: 3, Princes Mansions, VICTORIA ST., WESTMINSTER.

"ELECTRICAL DISTRIBUTION."—Commercially considered, with Estimates.

"MACHINE DRIVING BY ELECTRICITY."—The Uses of Electro-Motors for Traction and Stationary Purposes.

"THE TELPHER SYSTEM OF CHEAP TRANSPORT," for Minerals, Goods and Passengers.

"ELECTRICAL SUPPLIES."—Prices and Particulars of the most approved Electrical Appliances

ELECTRICAL PLANT ON VIEW.

Digitized by Google

THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 616.—Vol. XXIV. FRIDAY, MARCH 7, 1890. Price Fourpence.

NOTES.

Upon the Editorial staff of The Electrician this week devolves, perhaps, the most painful duty that men placed in their position can be called upon to perform. They have to announce the untimely death of their esteemed friend and chief, who, after a lingering illness, expired, under his father's roof at Tiverton, on Wednesday night, at the early age of 31. The loss we have sustained will be appreciated even by readers of The Electrician who recognised him only by his writings in these columns; but to those who knew him personally any expressions of regret from us will sound poor indeed—for William Henry Snell was a man, both intellectually and socially, of whom it is hard to speak except in terms of seeming exaggeration. Great as is our loss, the loss sustained by the electrical profession is still greater, for our late Editor was acknowledged among his *confrères* as one of the most brilliant and talented young men of the day.

At the meeting of the Institution of Electrical Engineers on Thursday last week the President announced that Sir David Salomons had made the munificent offer of £1,000 to found a scholarship of £35 per annum, to be held for three years, and to be entirely under the control and at the disposal of the Institution. The Council have gratefully accepted this offer, and have appointed a Committee to consult with Sir David Salomons and settle all details in connection with the scholarship.

Sir David Salomons' generous gift is one which we trust will not long remain the only instance of the kind. The premiums at present annually granted by the Council for Papers read before the Institution carry with them the maximum of honour and the minimum of pecuniary reward. The founding of a premium the intrinsic value of which bore some relation to its prestige would, we think, prove a great addition to the rewards within the gift of the Council.

The recent meeting of the National Electric Light Association at Kansas City, both from the point of view of attendance and of the value of the papers read, seems to have been a very successful gathering. Interesting reports were presented by the Committee on "The Standardization of Potential" and by that on "Harmonizing Insurance and Electric Lighting Interests," and many of the Papers read were of great practical value. An excellent *résumé* of the proceedings will be found in our New York letter.

A large portion of Mr. Sprague's interesting Paper on "Electricity applied to Street Railways," which will be found in another column, is devoted to an ingenious argument proving that it is the telephone companies and not the street railway companies who ought to employ complete metallic circuits. We are glad to note, however, that in spite of the strong position he takes up on this question, Mr. Sprague suggests that "a just compromise but no surrender" should be the motto of street railway companies, on the ground, we suppose, that a fair compromise is less costly than a legal victory. Mr. Sprague's Paper also contains a suggestive sketch of a plan for an electric express railway between New York and Philadelphia.

The Committee appointed at Frankfort-on-Main to inquire into the alternating and direct systems of distribution have issued a report, an abstract of which we publish, from which it appears that the Ganz alternating current motor has a very high efficiency (in some cases 88 per cent.), and maintains itself in synchronism even if the load is suddenly altered 60 per cent. above or below the normal. Although these results are already known to many, their importance is not yet generally realised. The excessive sparking of these motors when starting is a very serious defect. We, however, publish this week a proposed remedy, which appears very promising. Some years ago no direct current dynamo could be obtained which did not give rise to excessive sparking. Most of this has since been got rid of by allowing the armature coils to be short circuited under the brushes before the current through them is reversed. A similar method is now proposed by Zipernowsky, Déri, and Bláthy for the field magnet coils of alternators.

In a communication to the *Philosophical Transactions* on "The Diurnal Variations of Terrestrial Magnetism," Prof. A. Schuster has shown how to calculate the secular variations from the known values of the magnetic potential on the earth's surface. The calculations were compared with observations taken at Lisbon, St. Petersburg, Bombay and Greenwich, from which exceptionally trustworthy data could be obtained. The

Digitized by Google

interest and importance of the comparison consists, not only in the general agreement between the values given by the formula with those actually observed, but also in the fact that it is possible to partially locate the origin of the disturbances. The harmonic method of analysis employed leads to different results, according as the disturbing causes are supposed to be within or without the earth's surface, and the comparison of theory and experiment thus renders it possible to determine whether the main cause of the variations is outside the earth or not.

Prof. SCHUSTER finds that the principal part of the diurnal variation is due to causes outside the earth's surface, and gives good reasons for the supposition that electric currents in the atmosphere are the origin of disturbance. The results of the calculations, however, point to an additional source of variation within the earth's surface, standing in fixed relationship to the main source outside. This seems a natural consequence, since a variation of magnetic potential due to external causes would necessarily be accompanied by currents induced within the earth, and these would in turn give rise to fresh disturbances. The phase and magnitude of these currents lead to definite conclusions about the conducting power of the earth, and one of the most interesting of the results arrived at by Prof. SCHUSTER is that the earth does not behave as a sphere of uniform conductivity, and that the inner parts of the earth must conduct better than the outside crust. When allowance is made for the induced currents within the earth, when supposed to conduct in this way, the agreement between the observed and calculated values of the diurnal variations is exceedingly close.

IN a recent number of the *Comptes Rendus* M. JOUBIN describes some experiments made to determine the magnetic field within a conductor of large section. The conductor consisted of sulphate of copper placed in a vertical glass tube, 18 cm. in diameter, and reposing on a trough of mercury. The upper electrode consisted of a plate of copper placed on the upper surface of the copper sulphate. A small magnet furnished with a mirror was suspended by a silk fibre in the interior of the liquid. When the magnet was placed within a second tube in the axis of the liquid cylinder no force whatever was observed. As the magnet was moved along a radius of the cylindrical conductor the force became greater and greater, and it was found that in the immediate neighbourhood of the surface the action was the same, whether the suspended magnet was inside or outside of the conductor. These results are in conformity with theory, which states that the magnetic force at a point is directly proportional to the distance from the centre when within a circular conductor, and inversely proportional to that distance when outside, the two values coinciding at the surface. We are unaware, however, of any previous tests of magnetic force within the substance of the conductor.

IN the same magazine there is a communication from M. PAUL JANET showing that lines of force remain perfectly continuous in passing from one medium to another, whether the media are magnetised or non-magnetised, conducting or non-conducting. No assumption is made as to the constancy of the relationship between the magnetising force and the resultant magnetisation.

The London Electric Supply Corporation.—We are informed that Lord Crawford has resigned his position as Chairman of this Corporation in favour of Mr. J. S. Forbes.

Verity Cricket and Football Club.—A smoking concert in connection with this club will be held at the "Horse Shoe" Hotel, Tottenham Court-road, at 8 o'clock this evening.

Cathedral Lighting.—The lighting of the interior of Strasburg Cathedral by incandescent lamps has proved highly effective, and the arc lights used outside the building show off the details of the façade exceedingly well.

The Liverpool Electric Supply Company.—On Saturday last a dinner was held at the Adelphi Hotel by the *employés* of the Liverpool Electric Supply Company to celebrate the opening of the Company's new and extensive works at 15, Highfield-street.

Electric Light at the Venice Arsenal. — According to a report just published by the British Vice-Consul at Venice, the project for illuminating the whole Arsenal in accordance with the system adopted at Spezia has been sanctioned by the Italian Government.

Royal Institution.—At the general monthly meeting of this Institution on Monday last the special thanks of the members were returned to Mr. Warren De la Rue for his valuable present of a miniature portrait of his father, the late Dr. Warren De la Rue, F.R.S., M.R.I.

Telephonic Communication with Ships at Anchor.—The Havre Chamber of Commerce is about to carry out some experiments with a view of testing the feasibility of a system of telephonic communication between ships at anchor in the Roads and the local Exchange.

Port Said.—The Egyptian Minister of Public Works has authorised M. Sigmund Fahn to establish a telephone exchange at Port Said. The concession is to last 15 years, with option of purchase by Government at the end of ten. The concession carries no monopoly with it.

Personal.—We regret to hear that Mr. Lant Carpenter has fallen ill from overwork, and has been ordered to take a few weeks' complete rest. It was in consequence of this that Mr. Carpenter was unable to deliver his lecture on "Technical Education" at Toynbee Hall on Saturday last.

The Balloon Society of Great Britain.—The Council having determined to allot an evening a month to lectures and discussions on electrical science, persons desirous of reading Papers or attending the meetings are requested to communicate with the Secretary, 26, Budge-row, Cannon-street, City.

Apparatus for Demagnetising Watches.—A permanent horseshoe magnet enclosed within a box is rotated by means of a handle. To demagnetise a watch it is only necessary to rest it on the lid opposite the poles of the magnet, and to gradually draw it away while the magnet is rapidly rotating.

Devonport and Plymouth.—At a meeting of the Devonport Town Council on Thursday last week a report was read from the Highways and Streets Committee stating that the Devon and Cornwall Electricity Supply Company had decided to abandon the scheme at Devonport and Compton Gifford, and confine their attention to Plymouth.

Chelmsford.—At a meeting of the Town Council on Wednesday last week the Mayor reported that Messrs. Crompton and Co. had fixed Monday, April 14th, as the date on which they will be prepared to take up the contract for lighting the

Digitized by Google

streets of the borough. They will commence "running" next week, however, on their own account.

Wimbledon.—At a meeting of the Local Board on Wednesday night Mr. Holland proposed that the recommendation of the Electric Lighting Committee that the electric light should be adopted forthwith in Wimbledon be agreed to. A lengthy discussion ensued, several speakers objecting to the short notice given, and asserting that the matter was being rushed. The motion was, however, finally adopted by 7 votes to 5.

Railway Companies and the Telephone.—In several towns in Germany and Austria the railway companies have placed their goods yards in connection with the local exchange. By this means consignees are informed of the arrival of their goods, and merchants and shopkeepers are able to obtain any information they may require from the railway company without delay. This extension of the telephone system has proved very popular.

Physical Society.—Mr. Herbert Tomlinson is, we understand, suffering from so severe an indisposition that he will be unable to read his promised Paper upon the Villari Neutral Point in Nickel on Friday, at the next meeting of the Physical Society. On that occasion, in addition to Prof. S. P. Thompson's Paper upon Bertrand's Refractometer, a joint Paper by Prof. Dunstan and Mr. Dymond will deal with an apparatus for the distillation of mercury in a vacuum.

The Direct United States Cable Company (Limited).—This Company notify that they have opened to the public at 40, Hope-street, Glasgow, a new station for the acceptance, transmission, and delivery of American telegrams. The station is centrally situated, and will be found very convenient for American cablers, as the new office will bring the whole of the Company's system within the range of what may be practically termed immediate communication with the Scotch provincial towns.

The Copper Market.—The visible stocks of copper diminished during the month of February by 562 tons. Since the copper crisis at the end of March, 1889, the inroad upon stocks in sight has been nearly 30,000 tons, each month's consumption having exceeded the corresponding supplies. Stocks are now 95,152 tons, contrasted with 124,876 tons at the end of March last. The present price of bars is £47 per ton, compared with £39. 5s. on March 31st, 1889, to which copper had suddenly fallen after touching £100 in September, 1888.

Bridlington Quay.—At a meeting of the Local Board on Saturday last, Dr. Redman said he had had a telegram from Messrs. Laing, Wharton, and Down, stating that as the Board did not accept their tender for lighting the town at the last meeting, they were not now in a position to carry it out, as they had accepted other contracts. The Board resolved that the tender of the Bridlington Gas Company be accepted, and a committee was appointed to consider and report on the best means of lighting by electricity the whole of the district, with power to employ an electrician.

York.—At the last meeting of the Streets and Buildings Committee of the Town Council it was reported that the Yorkshire House-to-House Electric Company and the National Electric Supply Company had decided to withdraw their applications for Provisional Orders. It was also reported that objections to the application of the Corporation for a Provisional Order had been made by the National Telephone Company, the South of England Telephone Company, the Western Counties and South Wales Telephone Company, the North-Eastern Railway Company, and the York Tramways Company.

The Ganz Transformer.—In some tests recently undertaken by a committee specially appointed by the Town Council of Frankfort-on-Main to report on the alternating and direct systems of distribution, the efficiency of Ganz and Co.'s medium sized transformer came out at full load at 95 to 96 per cent., half-load 93 to 94 per cent., quarter-load about 90 per cent., and one-eighth about 80 per cent. An automatic switch by the same company was inspected by the committee, which was to cut out the transformers in groups so as to allow them as far as possible to work at full load.

Wiedemann's Annalen.—In a preface to the XXXIX. volume, Herr Wiedemann gives a short historical sketch of this well-known publication, which was founded in 1790, and has already undergone several changes of name. From 1790 to 1824, the *Annalen* were edited by Gilbert, after whom they were named. From 1824 until 1877, the publication was known as *Poggendorf's Annalen*, and in 1877 it became *Wiedemann's Annalen*. Previous to 1824 the *Annalen* were chiefly comprised of abstracts of foreign scientific articles; under Poggendorf the tone became more German; finally, in 1877, Wiedemann effected a further change by the publication of the monthly supplement.

Electricity at a Paper Factory.—For some time cellulose has been used in the manufacture of paper, but its extended adoption has been retarded by its high price. Dr. Kellner, Director of an Austrian cellulose factory, has, says the *Elektrotechnisches Echo*, succeeded in reducing the cost by the following process:—The shredded wood is put into lead-lined boilers with a 5 per cent solution of common salt, which is electrolysed for three and a-half hours. The nascent chlorine bleaches the wood fibre to a snow-white silky substance. The operation is conducted at a temperature of 126° to 128° Centigrade. The process is expected to have an important effect on the trade, as the paper made from cellulose is of particularly fine texture.

The Electric Light at Co-operative Stores. — Speaking yesterday (Thursday) at the annual general meeting of the shareholders in the Junior Army and Navy Stores, Major-General Hale Wortham (the chairman) stated that during the past year York House (Regent-street) had been fitted with the electric light. He felt sure that the shareholders would approve this proceeding, remembering that the electric light was conducive to a large saving in the cost of painting and decoration; and he might also tell them—what was probably known to many of them—that there was a great deterioration in perishable commodities when gas and similar lights were used. This deterioration did not occur where the electric light was used, to say nothing of the personal comfort of the members and the *employés*.

The Forth Bridge.—The opening of the "biggest engineering show on earth" has been worthily celebrated by our contemporaries, *Engineering* and *Industries*, by the publication of magnificent Forth Bridge numbers. The Paris Exhibition number of *Engineering* will be remembered by many of our readers; and the present one, devoted to the history of the Forth Bridge from its first inception to its completion a few weeks ago, is quite equal to, even if it does not surpass, that enterprising production. The Forth Bridge number of *Engineering* contains 70 pages of excellent descriptive and historical matter, 156 figures, and no less than 19 fine full-page plates. The Special number of *Industries*, although a highly creditable one, is scarcely equal to that of its contemporary, the engravings especially lacking in clearness. This number contains 52 pages, 122 figures, and five plates.

The Consent of Local Authorities to Provisional Orders.—Replying on Monday in the House of Commons to a question asked by Mr. R. K. Causton, Sir Michael Hicks-Beach informed the House that the Board of Trade had not determined not to proceed with any applications for Provisional Orders to supply electricity, if the local authorities refused their consent. In view of the Sessional Orders of Parliament the Board of Trade informed the promoters of Provisional Orders that they should not proceed with applications unless the consent of the local authority was produced by February 25th. Where, however, there was anything in a case to cause the promoters to request the Board of Trade to dispense with such consent their application would be carefully considered, and if there appeared to be exceptional circumstances connected with the refusal of the local authority an inquiry would be held.

Central London Railway Bill.—No fewer than 31 separate petitioners will appear in opposition to this Bill. Among the opponents are the Corporation of London, the Commissioners

Digitized by Google

of Sewers, the London County Council, the St. Giles's District Board of Works, and the vestries of St. James's, Westminster, St. George's, Hanover-square, Paddington, and Marylebone, the Gas Light and Coke Company, the Grand Junction, the East London, and the New River Water Companies, the Metropolitan, Metropolitan District, and the London, Chatham, and Dover Railway Companies. Among the other petitions are two from the owners and occupiers of property along the proposed line of railway, two from owners and occupiers of property in Oxford-street and Bayswater-road, two from the Mercers' and Skinners' Companies, and ten from landowners, including the Duke of Westminster, Viscount Portman, and the Ecclesiastical Commissioners. The remaining petitioners are the Gresham and Equitable Assurance Societies, the Metropolitan Electric Supply Company, the London Hydraulic Company, the Union Bank of London, and the City of London and Southwark Subway Company.

Curious Effect of Atmospheric Electricity on an Underground Telegraph Wire.—In a recent number of *La Lumière Electrique*, M. P. Marcillac, in commenting on some earth phenomena recently observed by Signor Palmieri, relates the following interesting incident connected with subterranean telegraph wires:—In 1883, while fault finding, M. Marcillac found himself in a wood between Marseilles and Toulon. The weather was fine and he was in telephonic communication with Marseilles by means of some excellent Siemens apparatus. The telephone was interposed in a circuit formed by two underground wires, and there was, strictly speaking, no earth and no overhead section. The weather suddenly clouded over, and a violent crackling was heard in the telephone. Rain soon fell, and obliged the party to seek refuge in their tents. At about three kilometres distance M. Marcillac noticed a grey-coloured cloud, shaped like an inverted cone, oscillating in a most extraordinary manner. Each oscillation of the cloud corresponded to a violent crackling in the telephone. The noise of the thunder prevented conversation, and a field Morse apparatus was rapidly installed to maintain communication with Marseilles. The effect of the oscillating cloud continued and caused the tongue of the Morse apparatus to be attracted with such force that in order not to sacrifice his apparatus M Marcillac had to put the line to earth. The rain fell in torrents for a few minutes, after which the phenomena ceased. M. Marcillac points out that this was not a question of earth currents, but of induction experienced in a carefully insulated subterranean line.

Brighton.—A special meeting of the Town Council was held on Monday last to consider the reports from the Lighting Committee and the Works Committee relative to the purchase of a site for a central lighting station, and the report of Mr. Shoolbred. After a discussion lasting over five hours, the various resolutions proposed were carried by large majorities. It was resolved to purchase the site offered by Messrs. Vallance, Catt and Co., for the sum of £7,000, to appoint Mr. Shoolbred electrical engineer, to accept the plans and specifications of Mr. Shoolbred, and to instruct the Town Clerk to advertise for tenders. The special resolution of the Council of January 23rd, adopting the extended area, was also passed.—The following are some of the questions put to Mr. Crompton by the Committee, together with his replies to the same, published in his report, referred to in our last issue:—(1) On the best system of generating and distributing the electric current in Brighton; (2) the site or sites at which the electricity can be most conveniently generated; (3) on the cost of plant; (4) on the cost of working the plant; (5) on the use of the Corporation Ash-yard as a site for a central station, with the object in view of utilising a portion of the town refuse as fuel; and (6) the comparative advantages of steam and gas engines for working the generating plant.—(1) the storage system; (2) either the site in Black Lion-street or that in Church-street; (3) £30,000 for plant and mains to supply 5,000 16 candle-power lamps lighted simultaneously; (4) the cost of producing a unit is estimated at 8·2d. if 100,000 units are sold, and at 3·6d. if 400,000 units are sold; (5) experiments to determine what is the calorific value of the town refuse ought to be carried out; (6) Mr. Crompton advises steam engines.

Electric Bills in Parliament.—The City of London and Southwark Subway Bill was read a second time in the House of Commons on Friday last. The following additional petitions against Private Bills have been deposited in the Private Bill Office:—Against the London Subways and Overhead Wires Bill: By the Conservators of the River Thames, the Great Western Railway Company, the Westminster Electric Supply Corporation, the Great Eastern Railway Company, the Commissioners of Sewers, the City of London and Southwark Subway Company, the London and North-Western Railway Company, the Wandsworth and Putney Gaslight and Coke Company, the Honourable Society of the Inner Temple, the Vestries of Hammersmith and Kensington; the South-Eastern, Midland, Great Northern, Metropolitan District, London, Chatham, and Dover, London and South-Western, Metropolitan, and East London Railway Companies; the London Hydraulic Power Company, Corporation of London, Commercial Gas Company, National Telephone Company, and the House-to-House Electric Light Supply Company, and others—in all 28 petitions. A petition in favour of the Bill has been deposited by the Vestry of Bermondsey. Against the City of London Electric Lighting Bill: By the Laing, Wharton, and Down Construction Syndicate, the City Commissioners of Sewers, the Brush Electrical Engineering Company, the District, the Metropolitan, and the London, Chatham, and Dover Railway Companies. Against the City of London and Southwark Subway Bill: By the London, Chatham, and Dover Railway Company. The Committee of Selection have held a meeting and formed the following Bills in groups:—The London Subways and Overhead Wires in Group A; and the City of London Electric Lighting Bill, the St. Martin-in-the-Fields Electric Lighting Bill, and the Strand Electric Lighting Bill in Group F. At a meeting of the General Committee on Railway and Canal Bills, the Central London Railway Bill and the City of London and Southwark Subway Bill were put into Group I.

Electricity in Warfare.—In a lecture on "Electricity in Warfare" recently delivered before the Franklin Institute, Lieut. Bradley A. Fiske, of the United States Navy, said, among other things, that it was in the modern warship that electricity had its broadest field: in no other equal space could there anywhere be found so many, so various, and so important forms of apparatus. In the United States cruiser "Chicago" one of the eight-inch guns was trained by an electric motor, and with gratifying results. The gun could be trained much quicker than by hand: but that was not the real element of superiority. The real element was the absolute control possessed by the gun captain. The problem of supplying ammunition with sufficient rapidity to carry on a modern engagement was one of the most important problems pressing for solution. The ammunition hoist now on board the "Atlanta" was a step in this direction, furnishing as it did a means for raising ammunition to the deck quicker than by hand, with greater safety and with fewer men. In this hoist, as in the gun training apparatus, the idea was carried out of making the electric motor follow the motions of the operator's hands, both in direction and speed. The operation of turning a wheel or crank caused the switch to start the motor in a certain direction. If the operator began to decrease the speed with which he turned the crank, the motor would overtake him, and would partially close the switch: the motor would therefore lower its speed; whereas, if the operator increased his speed of movement, the switch would thereby be opened further, and the motor would go faster. The advantage of this plan in the case of an ammunition hoist was apparent, since the entire time required on board of the "Atlanta" to raise a 250lb. shell was 9½ seconds. Now, this interval gave a man very little time to think, and if the ordinary arbitrary movements for starting and stopping motors were employed, an accident would some day result from the wrong movement being made. Furthermore, if a shot disabled the motor or its connections, everything stopped, and the shell simply stayed where it was. This was a much better thing for it to do than to violently descend, or be forced up against the deck overhead, as would happen with any other device now known.

Digitized by Google

MAGNETISM IN IRON AND OTHER METALS.*—VIII.

BY PROF. J. A. EWING, F.R.S.

(*Continued from page 417.*)

§ 44. To Find the Directing Force at the Magnetometer.—In measuring magnetism by the magnetometric method, we must know the force F_1 which directs the needle when it hangs in the undeflected position. Even when no special directing magnets are used, it is not safe to assume that F_1 is identical in value with the horizontal component of terrestrial magnetism, for the earth's field is often seriously altered within a room by the magnetic influence of iron pipes, beams, and so forth. So long as these disturbing bodies are not liable to be moved about, or to have their temperature much altered, their effect in modifying the magnetic field—though it may be considerable—will be nearly constant, and in that case an occasional measurement of F_1 will suffice. If there are iron heating pipes or stoves in the neighbourhood, the utmost care is necessary to see that F_1 does not vary. Fixed masses of iron at the atmospheric temperature are not a very objectionable feature in a magnetic laboratory; but it is difficult to exaggerate the nuisance that may be caused by an iron stove or steam-pipe liable to quick changes of temperature.

We may make an entirely independent measurement of F_1, following the well-known method which is used in measuring the horizontal component of the earth's field,† and taking care to swing the deflecting magnet in the place where the magnetometer is to stand.

But in general all that is required is to go through as much of this process as will serve to find the *relative* values of F_1 and the horizontal field F at a place where there is no local magnetic disturbance. In most places F is sufficiently well known from the results of recent magnetic surveys, so that the absolute value of F_1 may be deduced when we know the ratio it bears to F.

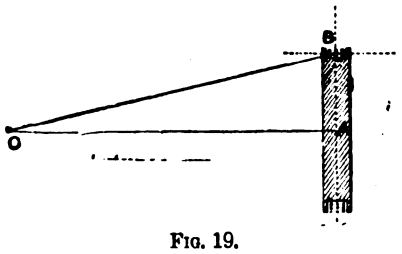


FIG. 19.

To compare the two, take a short straight piece of permanently magnetised steel wire, and suspend it to hang horizontally within a glass vessel by a little cradle and a silk fibre 3in. or 4in. long attached to the cover, so that it is free to swing. Put it where the magnetometer is to stand, and set it swinging torsionally (*not* pendulum fashion). This is most easily done by bringing near it a bar magnet, and then drawing that away, keeping the two poles of the bar equally distant from the hanging wire. When the swings have subsided so that the motion is no more than 5deg. or so to either side, begin to count them. Note with a watch the instant at which the magnet swings past its middle position towards one side, count 30 or 40 complete swings, and again note the time the magnet swings past its middle position towards the same side. Find in this way the time t_1 (in seconds) required for one complete swing. Then take the swinging magnet to some place (outside) where there is nothing to interfere with the terrestrial magnetic field, and repeat the counting there to find the time that is required to make one complete swing when the only directing force is the horizontal component F of the earth's field. The directing force is inversely proportional to the square of the period of swinging, hence the directing force at the place where the swings were first counted

$$F_1 = \frac{F t_1^2}{t^2}.$$

When the magnetometer is furnished with a "compensating coil" (§ 41) the following is a good way to find F_1. Remove the magnetising solenoid and set the compensating coil at a known distance, O A (Fig. 19), behind the magnetometer. Pass a known current, C,* through it and observe the deflection θ of the magnetometer. A B is the mean radius of the coil, and O A is measured to the middle of its width. Let q be the number of turns in the coil; then the deflecting force which is produced at O by the current in the coil is

$$\frac{2\pi C q \overline{A B}^2}{(\overline{O A}^2 + \overline{A B}^2)^{\frac{3}{2}}}, \text{ or } \frac{2\pi C q \overline{A B}^2}{\overline{O B}^3};$$

and, since this is equal to $F_1 \tan\theta$, we have

$$F_1 = \frac{2\pi C q \overline{A B}^2}{\overline{O B}^3 \tan\theta}.$$

§ 45. Example of a Test of Iron by the Magnetometric Method.—Before proceeding to describe the ballistic method of measuring magnetisation, it may be useful to illustrate the magnetometric method by giving the particulars of an actual experiment on a piece of wrought-iron wire.

The diameter of the wire (d) was 0·077 cm. The length of the specimen was 30·5 cms., or 400 diameters. It was annealed or softened before the test by drawing it through a lamp flame so slowly that each part of the length, in succession, was heated to bright redness and then cooled slowly as it passed away from the flame. The "one-pole" arrangement (§ 40) was adopted. A preliminary trial showed that the effective "poles" lay very near the ends of the wire. The upper one was set at a distance (O Q) of 10 cms. behind the magnetometer; the distance O Q′ to the lower pole was 31 cms.

The directing force at the magnetometer F_1 was 0·299 in C.-G.-S. units. The deflections were read in millimetres, and the scale was set at a distance of 1 metre from the magnetometer. Hence one scale division of deflection corresponds to a value of $\frac{1}{2000}$ for θ or $\tan\theta$.

Substituting these values in the expression of § 40,

$$I = \frac{4.\overline{O Q}^2 . F_1 \tan\theta}{\pi d^2 \left\{1 - \left(\frac{O Q}{O Q'}\right)^3\right\}},$$

we have I for one scale division of magnetometer deflection

$$= \frac{4 \times 10^2 \times 0{\cdot}299}{3{\cdot}1416 \times \overline{0{\cdot}077}^2 \times 0{\cdot}9665 \times 2000} = 3{\cdot}32.$$

Again, the magnetising solenoid contained 69 turns per centimetre of its length. Its magnetising force for one ampere of current was, therefore,

$$\frac{4\pi \times 69}{10} = 86{\cdot}7.$$

The current was measured by a mirror galvanometer, which was found to give a deflection of 575 scale divisions, with a current of 0·235 amperes. This corresponds to 0·000408 amperes per scale division. Hence the magnetising force for one scale division of the galvanometer was

$$86{\cdot}7 \times {\cdot}000408 = 0{\cdot}0354.$$

After the independent current (in a separate solenoid) which was required to balance the vertical component of the earth's force had been adjusted, the process of demagnetising by reversals was gone through to wipe out any traces of magnetism the wire might have acquired in handling. Readings of the magnetometer and galvanometer were then taken, while the current was slowly increased step by step from zero till the magnetic force reached a value of 22·27 units. Then the current was slowly and step by step reduced to zero, the magnetism retained by the specimen being observed at each stage, and then a negative current was applied, giving a reversed magnetic force, which was slowly increased until the residual magnetism began to become reversed. The results of the experiment are stated in the table on following page:—

* All rights are reserved.

† Full directions for the determination of the horizontal component of the earth's field will be found in Prof. A. Gray's "Absolute Measurements in Electricity and Magnetism."

*Here, as elsewhere, the current is expressed in absolute electro-magnetic (C.-G.-S.) units. If its value is known in amperes we must divide the number of amperes by 10 to find C.

Digitized by Google

TABLE I.—*Magnetisation of Annealed Iron Wire.*

(1) Magnetising current (Gal. readings).	(2) Magnetising Force.	(3) Magnetometer Readings.	(4) I
0	0	0	0
9	0·32	1	3
24	0·85	4	13
39	1·38	10	33
59	2·18	28	93
79	2·80	89	295
99	3·50	175	581
119	4·21	239	793
139	4·92	279	926
159	5·63	304	1,009
189	6·69	327	1,086
239	8·46	348	1,155
289	10·23	359	1,192
342	12·11	365	1,212
441	15·61	373	1,238
574	20·32	378	1,255
629	22·27	380	1,262
464	16·42	379	1,258
239	8·46	375	1,245
139	4·92	372	1,235
89	3·15	369	1,225
39	1·38	363	1,205
0	0	350	1,162
− 11·5	−0·41	342	1,135
− 23	−0·81	329	1,092
− 31	−1·10	318	1,056
− 41	−1·45	295	979
− 51	−1·80	253	840
− 62	−2 20	166	551
− 71	−2·51	70	232
− 81	−2·87	−12	−40

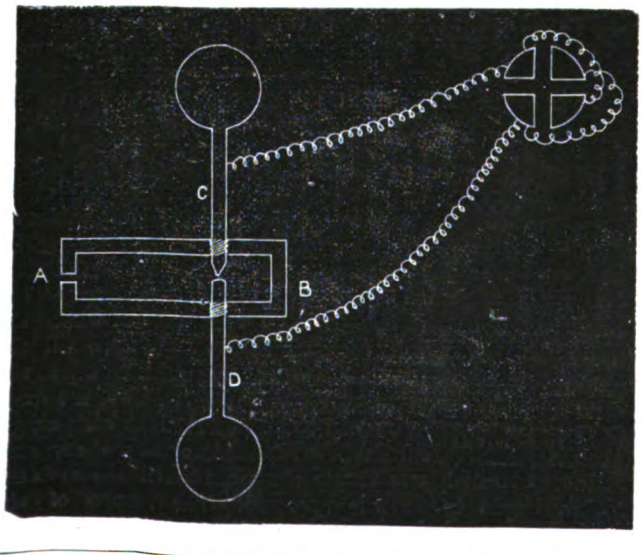
Column 1 gives the observed galvanometer deflections, and column 2 the magnetising force calculated from them. This is produced by the solenoid; in the notation of § 25 it is H′, and is a little greater than the true magnetic force H, which is diminished by the action of the ends of the specimen when it becomes magnetised. Column 3 gives the observed magnetometer deflections (due to the wire alone), and column 4 gives values of I calculated from them.

(*To be continued.*)

AN ELECTRICAL OSCILLATION DETECTOR.*

BY PROF. JAMES BLYTH, M.A.

The object of the note was to describe a form of oscillation detector which the author had found convenient in repeating the experiments of Hertz, Lodge, and others, especially as it obviated the necessity of working in a dark room. In consists simply in a thick-walled tube of vulcanite (*see* Figure), about 10in. long and ⅜in. bore, closed at one end B, and provided with a peep-hole at the other end A. Near the one end B two stout copper wires, C and D, are screwed through the walls of the tube, so as to be diametrically opposite, and in the same straight line. The end of the wire C has a long conical point, and is carefully polished, while the end of D is rounded and also polished. The other ends of both wires terminate in light copper balls. Each wire is about a foot long, and the diameter of the balls about three inches. By means of the projecting vulcanite tube, the detector can be easily fixed in any position by clamping in a retort-stand.



When the oscillator is at work, and the point inside the tube properly adjusted, a bright star-like appearance is seen when the eye is applied to the peep-hole, and thus a dark room is not necessary. For demonstration to an audience, the wires C and D are connected to the electrodes of a quadrant electrometer, and it is observed that whenever sparks are seen in the tube the spot of light moves erratically over the scale, becoming always steady when the sparks cease. By this arrangement the author had been able to repeat most of Hertz' experiments, and showed a few of the more characteristic of them to the meeting.

* Communicated to the Philosophical Society of Glasgow, January 8th 1890.

ELECTRICITY AS APPLIED TO STREET RAILWAYS.*

BY FRANK J. SPRAGUE.

Scarcely fifteen years, a period of time yet within the memory of the youngest of us, have passed since the beginning of a new era, the era of the transmission of energy for light, power, and the reproduction of speech. Of the progress of the first I need not speak, for the delegates of this Convention are well cognisant of its history and the advance it has made within that time. The spread of the telephone to nearly every town and hamlet in the fourteen years since it was exhibited as a scientific toy at Philadelphia, and the financial success of the parent company, are facts continually before your minds or ringing in your ears. But that industry, the transmission of electricity for power, with its possibilities of all kinds, is of very recent development. Six years ago there were scarcely a hundred electric motors in operation in the United States for any purpose. To-day there are no less than 15,000 motors in use, applied to not less than 200 different industries; and an industrial revolution is taking place equalling, if not surpassing, in importance that attending the introduction of the steam engine, and marvellous in the rapidity of its growth. It is not my purpose to dwell at length upon the subject of the transmission of power by electricity in its general application, but to touch upon one branch only, that of railway work, reviewing very briefly the development in the United States, pointing out the salient features of successful operation, noting what has been already accomplished, and, after some remarks upon the legal questions which have arisen, considering the possibilities of the future.

The first line which was established in the United States for actual commercial service was a suburban line of two miles in length, built by Mr. Daft, just outside of Baltimore, in the latter part of 1885, using a central rail. Other lines were established by Mr. Vanderpoele in various parts of the country, using the single and double trolley systems, with the trolley travelling upon and carried by the wire, and connected to the car by a flexible cable. Of the more recent work three classes demand attention, one being the system of independent units operated by the storage battery, and the other two being direct systems of supply, one underground the other overhead.

There is something exceedingly attractive in the proposed application of storage batteries to the propulsion of cars. To be able to conveniently store up a large amount of energy in a box, put it aboard of a car, carry it around with us, and take from it a greater or less amount of work, offers, when practicable, a solution of the street-car problem for which we are all devoutly hopeful. But look at it commercially. The storage battery is still a long way from being a serious competitor of the direct source of supply. True, great improvements have been made in it; but these improvements have not very much altered its character, or the weight which is necessary, or the care which must be exercised in getting an economical return from the battery. These improvements have made it possible to take a heavier charge from the battery without producing

* Read before the National Electric Light Association, Kansas City, February 14, 1890.

Digitized by Google

buckling, have made a rougher usage of the battery mechanically possible, and have in some instances greatly reduced its cost of manufacture, so that the element of maintenance is a less serious one than it was a year or two ago; but the capacity of the battery, while it has been somewhat increased, remains such that it is still necessary to have about 3,500 pounds to propel an ordinary street car. This means an excessive weight. It takes up space, and is a serious extra weight to be carried around. It requires frequent shifting, and its capacity as well as discharge rate are so limited that it is simply impossible to work such a battery upon grades which are at all severe. I believe it is possible with care to operate a storage battery on grades not exceeding, say, 4 per cent., and with limited speed and daily mileage at an expense about equal to that of horses, or a little less; but still at about double the expense which is necessary upon a suitably erected and properly operated overhead system. Nowhere in the United States, that I am aware of, is there serious storage-battery work being done at the present moment. The nearest attempt was where recent experiments were made on the Madison Avenue line, New York City, where about a dozen cars were being run until 8 o'clock in the evening; but owing to legal complications, only two cars are now running there; with what daily mileage I do not know. But nowhere is the work done at all equivalent to what is constantly practised on the overhead line. On that service motor-cars start out at 5 or 6 o'clock in the morning, and run until midnight. Many cars make 150 or 160 miles a day, and some cars have even made 180 and 190 miles a day. Half of this for storage-battery work is good duty, but it is not up to the demands which street-railway managers make, and until radical improvements are made in it, the field of application will be limited.

The conduit system of direct supply has been attempted in several places, notably at Denver, Cleveland, Allegheny City and Boston; but at all the places mentioned these experiments have proved disastrous and have been abandoned, save the short section at Allegheny City. In England, the Blackpool line under special conditions has been, I believe, fairly successful, and at Budapest the Messrs. Siemens have a conduit system in successful operation. There, however, the drainage is very perfect, and in addition a man is detailed for given sections of the track, and is continually employed in patrolling his section and clearing it out. Assuming good sewerage, the conduit can unquestionably be made to work. It becomes then a question of cost; but for general application, especially in view of the fact that most of our cities do not have a sewerage system which can take care of the street drainage, the expense is prohibitory save on large systems under exceptionable conditions. I look forward to the time when many existing well-constructed and well-drained cable conduits will become electrical conduits, and electricity will then score another victory.

The system, however, which has made such a marked advance is the single trolley overhead system, with universally flexible underneath contact, and this has been the growth of the past two and a-half years. I think I can fairly claim for the Sprague Company the pioneer place in this development; but the commercial development on the lines it laid down has been with great energy pushed forward, principally by both it and the Thomson-Houston Company. The first work done by the Sprague Company, other than experimental work on the elevated railroads, was made but a short distance from this city. A single car was started in 1887 on the Union Passenger Railway Company's line in St. Joseph, with a small 7½ horse-power motor, single-geared, and adapted to run at a very high speed on a suburban extension. It is a matter of interest that that line has seen nearly every change made in the system. Its lines have been extended twice, and it has both the old-style motors and the more modern equipments. But all the work done on that line in 1887 was, it may be said, purely experimental; and it was not until February 2, 1888, that the Richmond road was officially opened to the public. I speak of this road not so much because of my personal interest in it, but because it marked an era in the development of electric railways. A radical departure was made from the work which had been done prior to that time, not only in the amount and extent of the system equipped and the number of the machines operated, but also in the disposition and control of the machines, the system of overhead wiring, and the method of getting the current from the wire. The characteristics of that line are now pretty well known. It was a road of about 12 miles in length, with 30 curves, some of them of exceedingly short radius, with grades running as high as 10 per cent., and with a road-bed utterly unfit for the traffic which it had to support. The equipment was for 40 cars, requiring 80 machines, and was to be operated from one central station. When first proposed the attempt was looked upon with a good deal of ridicule, not only by street-railway men but by electricians themselves. The street-railway men thought that the ordinary condition of street-car service would make it impossible for a self-propeller car to ascend a grade exceeding 5 or 6 per cent., and as for attempting a 10 per cent. grade, that was out of the bounds of reason. As regards the electrical problem, the motors, instead of being placed on the car body flexibly, connected by chain gearing or belts to the axles, were placed underneath the car, and flexibly and concentrically geared to the axles. They were uncovered and exposed to the mud and moisture, and to all the loose combinations which might accumulate in the street. They were built to run on a 400-volt grounded circuit, and to run in either direction with fixed brushes. Insanity was a mild term to designate the mental condition of one who made these proposals. The motor man was confined to his ordinary platform, and the regulating devices there situated. A wire of one-fifth of an inch in diameter was extended over the track, and supplied at intervals of its length by a wire carried alongside the street where the strain upon the poles was least, and this main conductor was supplied at three or four central points by feeders, which came from the central station. The current, moreover, was taken from this wire, not by a travelling carriage upon the wire, flexibly connected with the car, but by an arm reaching upward and pressing underneath the wire. This contact arm, which is now technically known as the trolley pole, was placed in the centre of the car and had a universal movement, resisting up and down movement sufficiently to make a good contact with the wire, but at the same time free to follow all vertical deflections. In addition it had a lateral movement of considerable reach, offering little opposition to any side-deflections by the wire itself. Well, Richmond has passed into history. It has had its vicissitudes—it has had its victory as well. But it remains, with all its crudities, and with all the accidents which have marked its career, as the one great step in advance, whose features, in the main, have been followed in almost all the recent electric railways. Machines have been made larger; they have been made mechanically and electrically more perfect; changes of detail have been frequent, but most of the characteristic features there outlined mark to-day nearly every electrical railway which is either in operation, in process of construction, or under contract.

Taking our work alone, and that of 1887 as a basis, in 1888 it was trebled. The work of 1888 was quintupled in 1889. As to what it will be in 1890 I will not hazard a guess. Two years ago it was in an experimental stage, and it was difficult to get a dollar for investment; to-day it demands the best thought and the most active energies of two great corporations and a number of smaller ones. The contracts for electrical equipments involve larger amounts than almost any other electrical enterprise. The business done in this year will probably be not less than $6,000,000. Every street railway in the United States is watching with eager eyes the developments of the rival electrical interests. The advocates of the cable system are on the defensive. The advocates of the electric system are reliant and aggressive. Its flexibility, the ease with which it is extended, its adaptability to various conditions of service, its freedom from a long continued break-down, the marvellous advances which have been made in perfecting its apparatus, all ensure its supremacy. As illustrating the progress of electric railways, I may state that there are about 130 towns in the United States with one or more electric railways in operation, construction, or under contract, and that these roads comprise about 1,500 miles of track, equipped with about 1,700 motor cars, requiring 3,000 motors of an aggregate capacity of 45,000 horse-power.

As regards danger, the electric car is the safest possible vehicle, because of the remarkable facility of control, and as to the objections to the overhead line on the score of danger which have been raised, sometimes by the authorities, and which have been cited by the telephone interests, they are, we may safely say, imaginary rather than real. Some two years and a-half ago I settled upon 400 volts as a fairly satisfactory standard of potential for which the motor for street-railway service should be built, allowing about 10 per cent. drop in the distribution on the line, making the potential in the station about 440 to 445 volts. In some cases, where dealing with heavy work on extended lines and small conductors, we have raised the potential at the motors to about 450 volts, making no change whatever in the machine, and have run the central station at 480 to 500 volts. There are in the United States about 80 electric railways in operation. Almost every *employé* of the contracting companies, and a great many *employés* of the railway companies themselves, including not only the linemen, and those whose business it is to work upon the electrical equipment, but also the conductors and drivers, have received shocks from these lines, of greater or less duration, and under almost every possible condition. Yet, in no instance which ever came under my observation, or of which we have any reliable record, has serious injury resulted from the shock of the current itself. When we consider that these shocks have occurred to persons of all ages, and of all physical conditions, and for varying periods, the experience seems to be quite ample to warrant the assertion that, as ordinarily constructed, a constant-potential circuit of 500 volts is not dangerous to human life; and we can dismiss that question.

Reviewing the work of the past two years, that which was promised for electricity has been in the main entirely fulfilled. It has proved itself capable of doing the most extraordinary work under

Digitized by Google

the most unfavourable conditions. Grades of 12½ per cent., and more recently of 14 per cent., have been ascended with loaded cars. Grades three miles long, varying from 4 to 8 per cent., have been ascended by a motor-car pulling a tow-car. It has done this work where it would have been impossible to have done it by horses. It has enabled the running speed of cars to be increased even in crowded cities 50 per cent.; and on suburban routes speeds of 20 miles or more have been made. Experimental runs of 30 miles an hour on the ordinary street car with the narrow flange wheel have been attained; and on special experiments a speed of nearly 150 miles an hour has been attained for a short distance. The electric car has shown that it can run faster on both up and down grades; that it can be got under way and stopped more quickly than a horse car; that with any given number of cars the mileage has been increased, and at the same time intervals made with a less number of cars. Many cars have made from 180 to 190 miles in one day. Horse space having been saved, the equipments occupy a third less space; and this fact, coupled with the ability to back when necessary, and again quickly gain headway, has enabled an electric railway car in crowded and narrow streets to work its passage where a horse car would be at a dead standstill. Not only has the possibility of running down grade faster been established, but that possibility with a high degree of safety, because in the event of losing control of a car by the brakes, the instant reversal of the motor will bring the car to a standstill. This has frequently been the experience, and in one case which was recently reported to us the inspector stated that a car was going nearly 35 miles an hour on the down grade before the driver attempted to reverse his machine; but when he did reverse it he brought his car to a standstill with the loss of only one gear. Making due allowance for the possible excitement of the inspector, I think the car was moving at least 25 miles an hour when the reversal took place.

The cost of operation has proved entirely satisfactory, and my early claim has been substantiated. In a Paper read before the American Institute of Electrical Engineers in August, 1888, and also in some earlier communications, I made an estimate as to the expense of operating a thirty-car road, dividing these operating expenses under two heads: (1) those belonging to the central station; and (2) what may be called the road operating expenses; the sum of the two constituting the total cost of motive power. In making this estimate I used extreme care, and while preserving its accuracy, made every reasonable allowance that I thought necessary. The conclusion at which I arrived in the estimate under the conditions there given was, that the total cost of motive power per car mile should not exceed 4 3-10c. each, and this included everything except executive and salary expenses, taxes and insurance, and other matter not connected with motive power. I also stated that this was about 40 per cent. of the cost of operating by horses for the same number of cars and under the same conditions. My estimate was then considered altogether too liberal in favour of electricity. Without going into details, I may state that the most reliable possible records of roads, under every possible condition of service, bear out the claims that I then made as to the economical operation by electricity. I have the records of only a portion of the roads which we have equipped. Some roads see fit to make public these records; others, and with a good show of reason, do not care to do so because of the feeling that municipal bodies in considering the granting of franchises will not look at the increased cost of investment, but, ignoring the manifold advantages to be gained by the introduction of electricity, for the public as well as for the company, are inclined to make unreasonable demands in the way of the reduction of fares, or require unnecessary and unprofitable extensions of lines. But suffice it to say that careful investigation will convince any candid man that the economic claim has been entirely supported; and the best evidence of it is in the rapid adoption of this method of propulsion.

A few remarks may be in place relating to the interferences with other established interests which this new application of electricity has developed. There have been, long before electric railways became at all common, conflicts of a more or less limited nature between the electric lighting and telephone interests. In the early days of electric lighting, and more particularly in that branch known as constant-potential distribution, an attempt was made to use the earth for one-half of the circuit, precisely as was done and has been done for years in telegraphy. Practical experience, however, demonstrated that this was a mistake where incandescent lights were concerned, and it is manifestly a mistake where arc lights and high potentials are used. The objections on the constant-potential incandescent circuit were pertinent because of the liability of fire in the buildings where the ground circuit was used; and the element of personal danger very quickly put an end to an attempt to use a ground circuit for an arc light system. The same cautionary reasons applicable to these two classes of industries do not, however, apply to overhead electric railway systems. The electric railway circuit is purely an external circuit. Its derivations are through the cars which it supplies. It is led into no dwelling; its fixtures are not within the ordinary reach of any being. It is carried in the open air, in full view, in the most direct possible lines, and with only such supports as are necessary to make its construction safe and to keep it in alignment. The whole construction of an overhead electrical system is materially simplified, and, in my opinion, made, mechanically as well as electrically, far safer by the adoption of a single wire, using the rails as a return circuit. The practical proof of the wisdom of this decision is the fact that about 90 per cent. of all the electric railways, either in operation, construction, or under contract in the United States, use only the single wire underneath-contact. It scarcely seems necessary at this stage to go into the defence of this system. Its simplicity, the lightness of construction, the symmetry of outline, the size and strength of the poles, the fewness of the supports, the simplicity of all curve work, turn-outs, crossings, and sidings, and especially of all switch work and switch operations, are so manifest that elaboration of these features is unnecessary. The use of the grounded circuit has unquestionably interfered with another and widespread application of the use of electricity, and that is the operation of telephones which likewise use the grounded circuit. So long as electric railways were in an experimental stage, running, perhaps, in suburban districts, out of the way of telephone circuits, little or no attention was paid by telephone companies to their existence. The strides which have been made in the past two years and a-half, bringing the railway system into the very heart of towns and cities and into the forefront as a commercial enterprise, the rapid increase in the extent and use of the telephone system, have brought the two interests in direct conflict, which conflict is solely because of their common use of earth.

The claim of the telephone company in brief is, that, by right of prior occupation and because of their vested interests, no electric railway or other circuit shall so use the earth if interfering with their lines in any way. Their claim is far-reaching; it is of the broadest possible character, and, strictly interpreted, is an exclusive claim to the use of the earth for transmitting energy by electricity. That there is an interference with the telephone circuits by an electric railway circuit is undeniable, and the interference is one which is annoying. The character of the interference is two-fold—the trouble arises from induction or leakage. The relative amount of these two interferences has been variously stated. On the part of the telephone company, it is admitted that leakage is a source of trouble. They also admit that the use of any metallic return circuit—it matters not what, whether it be an individual circuit for each telephone, or a common metallic return for all the telephones—will obviate this, or most of it. Even this much is admitted by the telephone interests with a great deal of hesitation, despite its perfectly apparent truth. But they go further. They claim that this is not the principal cause of trouble, but that most of it is due to induction, and that if a return metallic circuit overhead were put up by the railway company—that is, if a double trolley system were used—then the telephone troubles would all cease. The various attempts they have made in the Courts have been with a view to either compelling the railway companies to cease operations or to so change and erect their entire system as to abolish the use of the single trolley and erect in its place the double trolley system, or, on the other hand, to compel the electric railway company to pay for the necessary changes required in the telephone circuit to avoid the interference. No sooner was this issue presented than it was promptly met by the railway interests which I represent.

Now, what are the facts? First, as I have stated, there is unquestionably an interference between the electric railway and the telephone service; but of the character of this interference, it seems to me that no intelligent man who honestly makes an investigation seeking after truth and truth only, and not biased by the commercial interests which have retained him, can have any reasonable doubt. The assertions made by the telephone interests leave little room for exaggeration on their part. Not only has the character of the interference been misrepresented, but the costs of any changes made necessary on the part of the telephone company to avoid trouble, or on the part of the railway company to change over its system, have been grossly mis-stated. As a matter of fact, the trouble from induction is of the very slightest character, and that must be patent to any one who is familiar with this particular electrical action. Generally the trolley wire is situated in the middle of the street, anywhere from twenty to thirty or forty feet away from the telephone lines. It rarely runs parallel to them except for a comparatively short distance—possibly two, or even three miles, but more often less. The current used upon this wire is not of that character which distinguishes some of the arc light circuits, but is of more or less even flow, and the abrupt and large changes due to change of load on the motor are comparatively infrequent. There is a very small change due to the variation of resistance of the armature of the motor, because of the different relative positions of the commutator blocks under the brushes, and there is likewise a variation due to the slight but rapid changes of counter-electromotive force set up by the motor when running. But although

Digitized by Google

these changes can be detected inductively, provided the conditions are favourable—for instance, if both the telephone and railway circuit were wound around a common bar of iron—the character of the disturbance is not so serious as to preclude conversation. But the trouble which does really become pronounced is that which is due to the actual differences of potential which exists on different parts of the track circuit—in other words, at the terminals of the grounded telephone circuit. There is discharged into the earth, as I have pointed out, a slightly varying current. It may be at some point considerably removed from the station and in close proximity to the ground terminal of a telephone whose exchange is likewise grounded at another point much nearer, electrically, to the station than the point of discharge. The current reaching the rail has to travel back to the station, partly by the rails and partly by the earth. Both offer more or less resistance, and there is an actual difference of potential between the point of discharge and the station, rising at times to as high as 20 or 30 volts; but it is, of course, a variable potential, and the current which flows over that path is one which varies in its character. Having discharged the current in the earth, there is absolutely no limit to its diffusion. We desire, of course, that it should return by the rails, but no boundary can be placed upon it. The shortest geographical line between two points may be a thousand feet. The paths of the current between these two points may be anything from a thousand feet to fifty thousand or more. But precisely as the rail current is thus disseminated or diffused in its return paths, so also is the telephone current. True, it is only a current of small capacity, so small as to interfere with no other enterprise or translating device except others of like character; but its diffusion is of precisely the same character as that of the rail current. Could the telephone current be limited in its path, and the claim of the telephone company be narrowed down to a specific section of earth, then, possibly, there might be some basis for the claim to the use of that section, but such a restriction is, of course, manifestly impossible. Hence, any claim the telephone interest makes to the earth must be vague; it must be all-reaching; it must be exclusive. It would seem that it has no more legal right to make a claim which prohibits a railway in the town in which the telephone circuits are operated from using the earth, than it has to make a claim that a railway in any other city with which the telephone may be remotely connected shall be prohibited likewise from using the earth in that particular city, although it may be a hundred miles off. It is a well-known fact among electricians, and probably no better known than among the telephone people themselves, that, perfectly independent of railway enterprises, a far better service can be rendered the patrons of the telephone where a complete metallic circuit is used and the use of the earth abolished. The telephone is the most jealous detecter possible of all disturbances of electrical condition on the circuit which includes it. Its very function as a transmitter of speech depends upon this marvellous delicacy. As now operated in the majority of telephone exchanges, it is subject to continual interference, not only from the railway circuit, but from every electric light, power, or telegraph with which it is brought into proximity. It is subject to interference from atmospheric changes and discharges. The telephone circuits themselves interfere with each other. Cross-talk and false signalling are common. Almost all these troubles can be avoided, and the telephone service made far more perfect, by using either the individual metallic return with the switch-board properly constructed for it, or the individual return, the return wires coming to a common terminus, which would make absolutely no change in the telephonic switch-board; or what has become known as the M'Cluer device, the use of an artificial metallic ground or common metallic return—that is, by breaking the ground connections of the individual telephones and connecting them all to one common copper return of a resistance which shall be low compared with the resistance of the instruments themselves. The lower the resistance of this common return the less any interference of the telephones with each other. The cost of this latter method is a bagatelle. It should be put up by the telephone companies for the sake of their patrons, independent of whatever other electrical enterprise they may be brought in contact with. Wherever intelligently put up the relief from outside interference has been almost absolute, and the testimony of parties who made complaint when telephone companies first sought to obtain an injunction against the railways is now emphatic to the relief which has been obtained by this change in the method of running the telephone circuits. It is unquestionable that the telephone company is waging the warfare from the standpoint of economy, pleading the rights of vested interest. Notwithstanding, every telephone expert knows the great advantage to be gained from a metallic circuit, and sundry Papers read at Telephone Conventions not only admit that the metallic circuit is best, but give testimony from the exchange superintendents that, wherever their patrons once use the metallic circuit and long-distance telephone, they are never satisfied thereafter to use the grounded circuit. It is likewise suggested that the Bell Telephone Company to-day advertise no less than about 150 local stations in New York City equipped with the long-distance telephone and the metallic circuit. Since there is not an electric railway in the City of New York, their action in this locality could not have been dictated by interference from that interest.

Since both the telephone and the railway companies occupy public streets by public licence, it is, of course, necessary to examine into the source of their respective titles, and the character of their occupancy, because otherwise it would be impossible to understand what are their respective rights. The electric railway has proved a great advance upon any method of street car propulsion hitherto known. The single trolley system being used by nine-tenths of the street railways in the United States using electric motor power, as against all other methods, certainly shows that practical experience is in favour of that particular method. As an improvement upon the method of propulsion, it would seem that an electric street railway uses a public highway, occupies the same, and enjoys the right of travel thereon as of equal dignity with any or all other persons or vehicles upon that highway, and that this right of enjoyment is within the original purpose for which the highways were opened. On the other hand, it is pertinent to inquire what right or title a telephone company has in the street. By virtue of the original dedication of the highway they have no rights except that of toleration. Telephone and telegraphs are identical in contemplation of law, and have been held to be an additional burden upon highways. In almost every case where this question has come up in the matter of telegraphs, such has been the decision. The statutes under which telephone or telegraph lines are permitted to be erected in highways provide that while they may be so erected, the poles and wires shall not interfere with public travel upon the highways. Since this is true the telephone companies are upon a public road not by virtue of right, but of toleration; not as the equals of the street railway, but subordinate to it. They occupy a secondary position, and, this being the case, where conflict arises between the two, it would seem that the telephone company must eventually yield; for its claim against any competitive enterprise is nothing less than a claim to the exclusive right of the earth. Certainly, no statute gives an exclusive privilege to a telegraph or a telephone company; and any claim for such an exclusive right, to be substantiated, must show an express or implied grant from some source, and the boundary as well as the source of that title. Not only this, but it must show that the title is exclusive. In view of the fact that the telegraph companies had used ground circuits for 30 years or more before the telephone was discovered, and that patents were refused for such use, it will be somewhat difficult for the telephone company to show the source of its title, and it is manifestly impossible to show the limits of the territory from which any other enterprise must be excluded so that it will in no way interfere with the operation of the telephone system; for the telephone circuits being attached to gas and water systems of the community in which it is located, the ramifications of such systems and of all the subterranean electric conductors of the earth in contact with these metallic conductors are unknown to science. How other electric currents entering the earth may do so without invading the charmed area of the telephone and disturbing its grounded wires no man can say, much less can the telephone people themselves. The boundaries, then, of their claim being so vague, it would seem that their claim itself must necessarily fail.

Within the past two years there have been, I believe, eight attempts made by the telephone interests to get an injunction. The first was in Akron, Ohio, in the latter part of 1888, where the Central Union Telephone Company of Chicago attempted to restrain one of the Sprague roads by injunction. This was denied. The next suit was against the Harrisburg road and the Sprague Company by the Penn Telephone Company. The case was abandoned and compromised for the very sensible reason that it would cost less on both sides to compromise than to carry the case to the higher courts. The next attempt on the part of the telephone interests was in the application for an injunction against one of our roads at Chattanooga, Tenn. This injunction was denied. Then came a conflict in Salt Lake City, where many of the people were so interested that they said, as between the telephone and electric railway interests, if the decision was against the railway company they would abolish the use of the telephone. Such heroic measures apparently were unnecessary, for the injunction was twice denied. Then application for an injunction was made in Cincinnati, and this will probably become a *cause célèbre*; for an injunction, on what ground I do not yet know, was granted, and the case will be carried to the higher courts. In Eau Claire, Wis., an attack was made on the railway interests under cover of a State law which the telephone companies had quietly got passed, requiring a return insulated conductor for any circuit carrying electric energy. The injunction was there denied, for the telephone company had somewhat overstepped itself, and found itself quite as much in the mud as the railway company might be in the mire, so far as the law was concerned, because they were themselves the carriers of electric energy and were

Digitized by Google

using grounded circuits, and consequently had no standing before the court. The last case with which we have been directly concerned is one at St. Joseph, which has not yet been tried. In Albany, where another electric railway company is operating, the telephone interest has succeeded in getting a temporary injunction. With the records thus given, it would seem that the electric railway companies have little to fear from the attacks made upon them by the Bell Telephone Company. A just compromise, but no surrender, should be the motto of the railway company.

I have been frequently asked whether, in my opinion, electricity will ever be used on trunk lines for through passenger or freight traffic? My answer is, probably not, according to the present notion of trunk line transportation, and not by present methods of train despatching. But with these qualifications I admit my hope and expectation of rapid through transit under certain conditions. Let us for a moment consider a few facts. Railroad managers are constantly meeting with a demand for more rapid and luxurious methods of transit. I think I can safely say that as steam railways are operated, a maximum speed of 90 miles per hour, and a running speed of 60 to 70, is all that can be hoped for in steam railway travel under the best conditions which can be provided. The limitations are too many. With respect to the electric motors, the question is not now, can a motor of sufficient capacity be built, or efficiently and positively controlled, but, rather, how can the electricity be produced and supplied to the motor and at what potential can we work. We all hope to see the time when electricity can be produced economically from coal without the intervention of engines or dynamos; and it may be that something akin to the present steam practice will be common; but I think that even then it will be quite likely that a central station method of distribution will be the more advantageous. On the other hand, there are those who hope to see the storage battery so reduced in weight and improved in other particulars as to warrant its use in a large way in locomotives. For myself, I prefer to consider the possibilities of another method—the amplification and development to its full capacity of present street railway practice; and for that purpose I will briefly consider a supposititious case, namely, an express between New York, or rather Jersey City, and Philadelphia. But before considering this problem let me point out a feature or two about steam roads. When first laid through a new country they usually consist of a single track, which must do the manifold duty of providing for through and local freights, and local and express passenger traffic in both directions. The route of such a road is determined mainly with the idea of getting from one place to another by a more or less direct line, but especially by one which shall not require too costly construction. The demands of traffic make a double track necessary, and as civilisation grows apace the freight traffic demands a track by itself, and four tracks constitute the equipment. So, following the development of the road, we will find that in time the express and local passenger trains may require individual tracks, and a six-track road will be a necessity. But it must be borne in mind that the express is not intended to cater to local travel. The highest demands of such a service would require that, independently of the local travel, a through express track should be constructed by the most direct route possible between the principal localities, and every effort made to reduce the curvature and grades as much as possible. No matter how much it costs to build such a road, when the traffic is sufficiently large it will pay to do it.

Suppose such a road to be an electrical one, and the method of supply to be from one or more central stations, the current being taken by a universally flexible underneath contact from a rod carried above the car, and the return circuit made by means of the rails. What the structure of the roadbed would be need not here concern us. We might use the standard T rail and roadbed, avoiding as much as possible curves, grades and grade crossings, and the overhead rod can be used simply for supplying the current; or some form of a double or single track road slightly raised above the ordinary level, and with the upper rod forming a steadying and centreing cord as well as a current supplier may be used. These are mechanical questions with which we need not concern ourselves at present. What does concern us, however, as electrical engineers is, whether the cost of copper, the potential required, the losses on the line, and the number of stations, are such as would be prohibitory. As regards the potential, other things being satisfactory, whatever pressure is demanded in the interest of economical and effective service will be used, and means will be found, consisting mainly in cars of construction, which will make its use for the purposes, and as intended, safe and proper.

From 8 a.m. to 9 p.m., a period of 13 hours, 21 regular trains leave the Jersey City station of the Pennsylvania road to run through to Philadelphia; 12 of these make but one or two stops. In addition to these there are a number of local trains serving way stations. Taking the through trains only, and allowing an average of say five cars to a train, there are in the 13 hours about 105 through cars despatched from Jersey City, or at the rate of one car every 7½ minutes, and of the through trains not making over one or two stops there would be one every 13 minutes. We will suppose an additional express track has been built, leaving the distance about what it is now, say 90 miles, but that the grades have been eased and the worst curves rectified. For the practical purposes of this Paper I will consider that the road is level, that the cars are to be despatched in 2-car units on a perfect block system, and to run through to Philadelphia with not more than one stop, at fixed intervals, and at a high average rate of speed, say 60 miles per hour. In the systems that I would propose, practically that with which I experimented some years ago, slight grades would make little difference in the general result, especially if the grade percentage, if expressed as a whole number, did not exceed the quotient of the traction in pounds per ton divided by 20, because when $C = \frac{t}{20}$, where t = traction in pounds per net ton and C = grade percentage expressed as a whole number, the work of traction and of lifting are equal. For example, suppose $t = 10$ pounds and $C = \frac{1}{2}$ per cent., and that we had on a double track one unit coming down the grade and the other ascending it, both at the same speed: then gravity would be supplying just enough power to propel the car on the down grade at a fixed speed, and enough power to supply the lifting and traction work of the other car would have to be supplied, which would be just the amount required to propel both cars on a dead level. Suppose the grade to exceed the ratio expressed above, then the car on the down grade would have an excess of falling energy, and this could be used in accelerating the speed of the car, or on the brakes, or it could be used by a process of reconversion for the purpose of supplying at short range part of the extra energy required by the ascending train. Just how this can be done is pretty fairly understood by electricians. All motors starting running on a level, or ascending a grade, would be requiring currents. All motors running on a down grade with just that velocity which the force of gravity would give them would require no current; and motors running on down grades of greater percentage than is required to give them power for traction, or motors slowing down, would be generating currents to aid in the general supply. No other system of distribution can by any possibility have this very remarkable interchange of energy. When running at a particular speed a slight movement of a regulating handle would make the motor receive from or give to the line currents in any desired quantity. The braking power of a motor thus acting as a generator is very powerful and the most perfect imaginable; because, unlike the ordinary methods, the brake does not operate if the wheels stand still, the very essential of the braking operation requiring the wheels to turn. It is a well-known fact that the most effective brake-work is when the wheels do not skid upon the track, but when they are turning under the pressure of the brake; and, contrary to the ordinary braking practice, the energy of the electric train, instead of being thrown away in the form of heat and using up our wheels and brake-shoes, can be made useful in the propulsion of other trains. I have tried this method of braking with such a degree of refinement that a heavily-loaded car would creep on a down grade at a pace so slow that an egg could be put under the wheels and cracked and removed before the wheel would pass over it.

Having thus touched upon the characteristics such as I would propose for a railway system of this kind, let us resume the consideration of our proposed line between New York and Philadelphia, and try to form some idea of the electrical pressure which would be required, the service which could be demanded, the number of cars which could be handled, the speeds which could be maintained, and the number of stations which would be required to operate the stations. We will assume for the purpose of this investigation an overhead conductor in the form of a solid rod one inch in diameter over each track, or, if you please, a smaller rod over each track, and a main conductor making up the equivalent capacity proposed, and a track of equivalent capacity. I take this arbitrary size because it is convenient for the purposes of our calculations, and because it falls well within the limit of expenditure which such a system would warrant. For instance, the American Bell Telephone Company has a line of long-distance telephone wires rounding from New York to Boston, a distance of about 300 miles, nearly three and a-half times the distance which we are considering. On these poles are about 70 wires each of No. 12 copper. The aggregate area of these conductors is over 800,000 circular miles, and the total weight of copper on this line, which is used simply for telephonic purposes, is about 40 per cent. more than the weight of two copper rods an inch in diameter running from New York to Philadelphia. If the investment is a reasonable one in the telephone system, cannot we certainly consider it a reasonable one in that larger field of the transmission of power of which we are now speaking?

As I have stated, of the number of trains which in 13 hours leave Jersey City for Philadelphia, 12 usually make only one or two stops. Allowing 60 cars, this would be about one car every 13 minutes. This interval of 13 minutes is nearly as short as would be desirable between cars running at an average speed of a mile a minute, no matter how perfect the block system, and it would be necessary, possibly, to run these cars in double-car units.

Digitized by Google

We will assume for our purpose the size of a car such as is used on the elevated road of Brooklyn bridge in New York, which would with motor and passengers weigh from 20 to 25 tons, or a total of, say, 50 tons for our unit. The formula to determine the size of conductor for a single transmission of car is

$$C M = \frac{15666\, n\, l}{e\, v\, p},$$

where n = the number of horse-power, l the distance in feet, e the potential at the motor, v the fall in potential, and p the commercial efficiency of the motor. If we assume the station situated in the middle of the line—that is, at the best point—and the work divided equally at the middle section on each side, then, l being the length of line, we have the formula

$$C M = \frac{15666\, n\, l}{4\, e\, v\, p}.$$

This will be practically the same if the work is distributed over the entire line.

If more than one station is used, then the formula will become

$$C M = \frac{15666\, n\, l}{4\, e\, v\, p\, s^2};$$

that is, the size of the conductor would vary inversely as the square of the number of stations (s), if properly distributed. v may be expressed as a fraction of e, and, for practical purposes, we will let $v = \frac{1}{9}$th of e and p, such that

$$\frac{15666}{p} = 16800;$$

that is, p = about 93 per cent. Then we have

$$C M = \frac{37800\, n\, l}{e^2\, s^2},$$

which may be expressed thus: that the size of the wire varies inversely as the square of the product of the number of stations and the electromotive force.

We may also note that with any fixed size of conductor the electromotive force and the number of stations vary inversely, a somewhat important fact to remember.

We have another formula, one for the power required by a moving car, which is

$$\text{horse-power} = \frac{4}{75}\, w\, m \left(c + \frac{t}{20} \right),$$

where w = the weight in net tons, m = the miles per hour, c the percentage of grade expressed as a whole number, and t the traction in pounds per net ton.

As I have stated, we will assume in this formula that c equals zero, a consideration in which I am justified in express service on a road of the character I have outlined, with the relation of grades and traction given, and with the method of braking I have described. Our formula would then become, using 10lb. per ton as our average traction,

$$\text{horse-power} = \frac{2}{75}\, w\, m,$$

which, substituted for n in the distribution formula, gives us

$$C M = \frac{1008\, w\, m\, l}{e^2\, s^2};$$

or, substituting for l 5280 d, d being the number of miles between stations,

$$C M = \frac{5322240\, w\, m\, d}{e^2\, s^2}.$$

We have assumed for our conductors two rods an inch in diameter, and that the rail has the same resistance. Hence, substituting for C M its value 2,000,000, we have

$$e^2 = \frac{2{\cdot}66112\, w\, m\, d}{s^2},$$

or

$$e = \frac{1{\cdot}631}{s} \sqrt{w\, m\, d}.$$

It will be noted that m, w, and d—that is, number of miles per hour, weight-handled, and distance over which operated, are all affected in the same way. Hence, with any value of e and s we can vary the relative values of w, m, and d so long as we do not disturb the product. That is, we can halve the number of miles and double the speed, or double the distance and halve the running speed, keeping the weight hauled the same, and so on. For the total weight we can substitute the weight of each unit, c, and the number of units, b, thus making the formula

$$e = \frac{1{\cdot}631}{s} \sqrt{m\, b\, c\, d}.$$

For the line proposed $d = 90$, and we have

$$e = \frac{15{\cdot}56}{s} \sqrt{m\, b\, c}.$$

Taking our unit of two cars at 50 tons, the time intervals between them as ten minutes, and 60 miles per hour as the mean speed, we have on the whole system 18 active units of two cars each, and

$$m\, b\, c = 54000$$

which substituted in our formula is

$$e = \frac{3616}{s}$$

which means that with one station in the middle, the potential at the motor farther from the station would be 3616 volts, and near the station one-ninth higher. Can we handle it? Yes, in time; but, perhaps, not yet. Nor is there any necessity for doing so; for if we increase the number of stations and go to a 3-wire, instead of a 2-wire system, making the track the balance circuit, we would have motor potential as expressed by the following table:—

Stations.		Motor Potential.	
Number.	Miles apart.	2 Wire.	3 Wire.
1	—	3616	1808
2	45	1808	904
3	30	1205	603
4	22½	904	452

Which last brings us down to ordinary street-car practice, which is only the beginning of what will be done in the effective handling of potentials. So, after all it does not seem such a serious electrical problem, and certainly not one to shrink from. We can in another way illustrate the influence of the position and number of stations and the potential used. Suppose we had a station at Jersey City to supply the entire line as a certain potential over a conductor of the required size. If the station be moved to the centre, the weight of copper necessary is only one-quarter. Use two stations properly spaced and the weight is quartered again. Double the potential and the weight is further quartered. Now use the 3-wire system and the weight is again quartered. So that by these very simple processes the original weight has been reduced 1-256th of the original.

I do not think I need to point out further the value of a proper determination of electrical values in a problem of this character. We see, then, that the suppositious case is well within the range of possibilities. A 60-mile express service every ten minutes instead of 40 to a 45 mile service every hour, would revolutionise travel. Of the comforts of such a mode of travel, I need not speak. That it will in the not very distant future be a fact, I know you all agree with me in hoping for.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-night) FRIDAY, March 7th.

PHYSICAL SOCIETY.

5 p.m. Ordinary Meeting. Papers to be read: "Bertrand's Refractometer." By Prof. SILVANUS THOMPSON, D.Sc. "An Apparatus for Distillation of Mercury in a Vacuum." By Prof. DUNSTAN and W. DYMOND.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "Electrical Relations of the Brain and Spinal Cord." By FRANCIS GOTCH, B.Sc.

SATURDAY, March 8th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture: "Electricity and Magnetism." By the Right Hon. Lord RAYLEIGH, F.R.S.

SOCIETY OF ARTS.

3 p.m. Popular Lecture I.: "The Atmosphere." By Prof. VIVIAN LEWES.

TUESDAY, March 11th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Papers to be discussed: "The Hawkesbury Bridge, New South Wales." By C. O. BURGE, M.Inst.C.E. "The Construction of the Dufferin Bridge over the Ganges at Benares." By F. T. G. WALTON, C.I.E., M.Inst.C.E. "The New Blackfriars Bridge on the London, Chatham, and Dover Railway." By G. E. W. CRUTTWELL, M.Inst.C.E.

WEDNESDAY, March 12th.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. "The Chemin de Fer Glissant, or Sliding Railway." By Sir DOUGLAS GALTON, F.R.S.

THURSDAY, March 13th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. Adjourned Discussion on the following Papers:—"The Theory of Armature Reactions in Dynamos and Motors," by JAMES SWINBURNE; and "Some Points in Dynamo and Motor Design," by W. B. ESSON.

Digitized by Google

The Electrician.

Published every Friday. Price Fourpence; Post Free, Fourpence Halfpenny.
Editorial, Publishing and Printing Offices:

SALISBURY COURT, FLEET ST., LONDON, E.C.

Telephone No. 2714. Telegrams: "ELECTRICIAN NEWSPAPER, LONDON."

All Communications to be addressed to "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN."

All letters intended for insertion in "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. Subscribers should receive their copies by the first post on Friday morning.*

"THE ELECTRICIAN" *is on sale at the railway bookstalls throughout the United Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices as above.*

SPECIAL NOTICE.

Owing to the increase in the number of pages of "THE ELECTRICIAN," in order to partly cover the increased postage, we have been compelled to revise the rates for Foreign Subscriptions, which are now as follows:—

	3 months.	6 months.	12 months
For Foreign Parts and Colonies:—	s. d.	s. d.	s. d.
Within Postal Union	6 6	12 6	24 0
Aden, Borneo, Ceylon, China, India, Japan, Java Labuan Mozambique, New Caledonia, Persia, Philippine Islands, Siam, Transvaal, and Zanzibar	7 6	14 6	28 0
The rates for the United Kingdom remain as follows:—	5 0	10 0	19 6

TO ADVERTISERS.

"THE ELECTRICIAN" *offers exceptional advantages to Advertisers.* **It has the largest circulation of any English Electrical paper, and circulates all over the World.**

Particulars relating to Advertisements will be promptly forwarded on application to the office.

TRADE ADVERTISEMENTS *intended for the current issue must be handed in not later than First Post on Thursday morning.*

SMALL PREPAID ADVERTISEMENTS *(for Rates see page xv.) are accepted up to 4:30 p.m. on Thursday.*

TECHNICAL PRINTING.

"THE ELECTRICIAN" PRINTING AND PUBLISHING COMPANY (LIMITED) *beg to inform Electricians, Electric Light Engineers, &c., that they make a specialty of Technical Printing, and have a Staff thoroughly acquainted with Electro-Technology. They can, therefore, promise Accuracy and Despatch in the Printing of Electrical Catalogues and Electro-Technical Literature generally.*

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.

Royal 8vo, 5s., postage extra.

Early in each year is issued "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK. *The* DIRECTORY *was established in 1883, and the 1889 Edition consisted of more than 600 pages of printed matter. The names and addresses of all persons engaged in the Electrical Industries may be relied upon as accurate. Useful Tables and Electrical Formulæ, and information specially compiled for this work are given, together with popularly-written Biographical Notices of the leading Electricians, Electrical Engineers, &c., accompanied in many cases by Portraits.*

The issue for 1890, which is still further enlarged and improved (making 850 pages), is NOW READY. Orders should be forwarded at once to the Publishing Offices, Salisbury-court, Fleet-street, London, E.C.

CONTENTS OF THE CURRENT NUMBER.

NOTES 437
Magnetism in Iron and other Metals.—VIII. By Prof. J. A. Ewing, F.R.S. Illustrated. Continued 441
An Electrical Oscillation Detector. By Prof. James Blyth, M.A. Illustrated 442
Electricity as applied to Street Railways. By Frank J. Sprague 442
Meetings of Scientific Societies. 447
SEEING BY ELECTRICITY 448
The Institution of Electrical Engineers—
Some Points in Dynamo and Motor Design. By W. B. Esson, Member. Illus. Continued 450
The Zipernowsky-Deri-Blathy Synchronous Motor. Illus... 452
The Weymersch Battery 454
American Notes 454
CORRESPONDENCE—
Testing Galvanometers.—W. E. Ayrton 455
Sectional Conductors for Electric Tramways.—W. E. Ayrton 455
CORRESPONDENCE—*Continued.*
The Wynne System of Electric Traction.—Frank Wynne 456
Cost of Electric Traction on the Barking Road.—H. J. S. Heather 457
The Life and Efficiency of Glow Lamps.—David Salomons and C. J. Robertson, A.I.E.E. 458
Rival Back Blocks.—J. J. Hine. Illustrated 458
The City of London and Southwark Subway Railway 458
The "Compactum" Feed Water Heater. Illustrated 459
Trade Notes and Notices 459
LEGAL INTELLIGENCE—
Aron Bros. *v.* Watson Bros... 460
Christopher *v.* Langworth and Others 460
In re James Fyfe 460
COMPANIES' MEETINGS, &c.—
The Telegraph Construction and Maintenance Company (Limited) 460
City Notes, &c. 461
Companies' Share List 462

"THE ELECTRICAL WORLD" OF NEW YORK.

"THE ELECTRICAL WORLD" OF NEW YORK *can be obtained from* "THE ELECTRICIAN" *Office, Salisbury-court, Fleet-street, London, E.C. The Rate of Subscription (payable in advance), is* **£1 1s.** *per annum. Single Copies* **price 6d. each; post free, 8d.**

"THE ELECTROTECHNISCHE-ZEITSCHRIFT" OF BERLIN.

In future the above journal (with which has been incorporated "The Centralblatt für Electrotechnik") will be issued weekly instead of fortnightly, the subscription being **£1. 4s. 6d.** *per annum. Single Copies* **6d.; post free, 7½d.**

"THE ELECTRICIAN" PRINTING AND PUBLISHING COMPANY, Ltd., *are Agents in Great Britain for both the above well-known journals, and particulars as to Advertisements will be supplied on application to* "THE ELECTRICIAN" PRINTING AND PUBLISHING COMPANY, Ltd., *Salisbury Court, Fleet Street, E.C.*

SEEING BY ELECTRICITY.

Shall we ever see by electricity? If a cable or a mere line of wire is capable of conveying, not merely signals, but sounds, music, and even speech, by means of electric impulses transmitted through it to a far distant spot, why should not the same medium of communication, actuated by the same subtle agent, be used to convey to us pictures of men and things? This question was frequently asked a dozen years ago when electric telephoning was a comparative novelty. The world awoke to the fact that it could hear through an electric wire, and forthwith it demanded that through an electric wire it should also be allowed to see. That no practical means have yet been discovered to solve the problem of seeing by electricity is not the fault of the inventor; for many inventors, even amongst the ablest and most successful, have attempted its solution. Neither is it the fault of the capitalist; for, assuredly, plenty of money can be found when needed to exploit so splendid an invention, if once the invention is made. Yet the world still waits expectant, and the invention seems no nearer than it was ten years ago.

To the casual observer, uninitiated in the secrets of physics, it is perplexing that any such delay or difficulty should arise in the designing of an instrument of such obvious value. It is an everyday fact that electricity can bring light into our

Digitized by Google

houses, can illuminate them with a brilliancy unrivalled by any other artificial means. If, then, electricity can convey electric light, and can also enable us to convey speech, why should it not also enable us to convey sight? The answer to this presentation of the problem is, that the physical basis of vision is in reality much more complex than the physical basis of audition; and that though an electrical mechanism can be contrived of quite a simple character which will virtually listen to a sound at one end of a line and repeat it audibly at the other end, it is in the very nature of things that no simple electrical mechanism is possible—at least, by the light of present knowledge—which will view an object at one end of a line and reproduce an image of that object visibly at the other end. Consider how essentially different is the physical structure of the ear from that of the eye. A drum-skin which can be pushed inwards or drawn slightly outwards by the impact of the sonorous impulses transmits the motion of its middle-point through a chain of little bones to the interior nervous apparatus. The impulses come one after the other successively in time, and all that the hearing mechanism has to do is to receive these impulses, large or small, brief or dilatory, and transmit them one after the other to the nerve structure. Speech, song, music—noise, indeed, of any kind—is made up of a succession of impulses. All that a mechanical chain of bones is required to transmit from the outer to the inner structures of the ear can equally certainly be transmitted along an electric wire. There is no crossing of impulses, no focussing, no question of impact on specific portions of the tympanic surface, merely succession in time, all impulses travelling at the same rate in the one case mechanically along the chain of little bones in the ear, or in the other case electrically along the wire.

In the eye, however, the physical mechanism is of quite a different order. A beautiful combination of lenses, one of them liquid, with two others of a gelatinous nature behind them, actually focuses the light-waves upon a sensitive surface, which is differentiated into hundreds of thousands of separate structures, each one of which is capable at the same time of receiving a distinct impression. When a complex object, such as a landscape, the page of a book, or a human face, is viewed by the eye, wavelets of light emitted or reflected from each minutest part of that object enter the eye, cross one another, and focus themselves on the structures of the retina, forming there an "image" inverted top for bottom, and "perverted" right for left. The minute structures of the retina, the so-called "rods and cones," feel simultaneously all the details of this inverted and perverted picture, and in turn transmit to the sentient brain the impulse caused by the breaking of the wavelets on each of them. These rods and cones are packed together, about twenty-five million of them to the square centimetre, or about at the rate of one hundred and sixty million of them to the square inch. Suppose a page of printed paper ten inches square is placed in front of the eye, at an easy distance for vision: its image on the retina of the eye will about cover one single square centimetre, or a space in which there are over twenty millions of separate sensitive structures, each one of which can, simultaneously with all its fellows, feel that detail of the page the image of which falls upon it. A human face five feet away will similarly form an image, covering perhaps a million separate sensitive points. These points feel the details of the image, and if the face is known to the beholder, a single instant suffices for recognition. A flash of lightning, lasting perhaps the hundred-thousandth of a second, suffices to reveal a landscape or a score of faces, the eye being able to grasp simultaneous impulses coming, in the form of waves of light, simultaneously, in a number of different directions at once.

Now, consider what sort of an electric mechanism could possibly act as a far-seeing eye, in the same sense as a telephone acts as a far-hearing ear. The transmitting part must resemble the retina of the eye in being differentiated into a vast group of minute independent structures, sensitive electrically to light. Theoretically these could be constructed out of selenium cells, selenium being, as every electrician knows, sensitive to light. Imagine, then, a set of selenium cells, a million in number, arranged like the squares of a chess-board, or like the cells of a honey-comb, side by side—if each is only of the size of one square millimetre this electric retina will occupy a square metre of space; in front of this, a combination of lenses to form an image, which combination could not well have a less focal length than one and a half metres. 'Tis a gigantic electric eye. But the transmitter is only half the apparatus. At the other end must be a receiving apparatus to reproduce the image. This must be a similar sort of chess-board or honey-comb, the cells being, however, composed not of something which is electrically sensitive to light, but of something which is optically sensitive to electric currents. Each cell must, in fact, emit light when an electric current passes through it. It is possible to conceive of some as yet uninvented glow lamp of extraordinary delicacy that may serve the purpose. Or each cell may consist of a mechanism that uses secondary light; an electro-magnetic apparatus that withdraws a shutter from a minute illuminated pane, or turns a mirror to a proper reflecting angle, being within such a category. Each minute cell in such a receiver must then be connected up by a special line to its own corresponding cell in the transmitter. Such an array of lines from cell to cell is appalling to imagine. Given, however, the apparatus we have thus schemed out, it is easy to see that whenever any object is placed within the field of view of the transmitter, an image of it, not in colours but in a mere monotone of tint, will be reproduced by the receiver at the distant station. The conditions are, however, so improbable, the arrangements so complex, that the problem of constructing a practical far-seeing instrument on these lines is not likely to come to any practical solution. Perhaps one day some sort of electro-optic action may be discovered, entirely different from that which light exercises on selenium, which may place the problem on a wholly different and simpler basis.

At present the main difficulty lies not so much in the design of transmitting or receiving organs as in the necessary complexity of an apparatus which shall enable innumerable points in the transmitting and receiving retinas to be actuated simultaneously in perfect independence but also in perfect correspondence. If it were not desired to obtain actual views—if, in fact, simultaneity of action were not insisted on—then one line wire, successively connected to the separate corresponding points of the picture at the transmitting and receiving ends by some appropriate synchronising mechanism, might be made to do duty for a large number of cells, instead of employing a separate line for each. But this is not seeing by electricity; it is merely reproducing a pattern or print automatically, point by point, by electricity. And, indeed, this was done nigh ten years ago by Mr. Shelford Bidwell, when he devised his telephotographic apparatus. Since that time the subject of electric transmission of pictures has not advanced a single step. We do not, of course, forget that it is now proven that light is itself an electric phenomenon—that waves of light are, in fact, electric waves—and that all seeing is really seeing by electricity. But, since it is a fundamental point in the modern science of electricity that all conductors so-called are necessarily opaque to electric radiation, the recognition that light-waves are electric waves adds nothing to the possibility of seeing through an electric wire.

Digitized by Google

It has not yet been shown that a vibration having a periodicity of 20,000 per second can be transmitted through an electric wire, whether of iron or copper, of even so moderate a length as ten miles. The periodicity of the slowest light-waves (those that are at the red end of the spectrum) is about 400 millions of millions per second. It may be doubted whether alternate currents of such high periodicity can penetrate through a copper wire an inch long. Hence the direct transmission of electric waves that should correspond to the impinging light-waves, in the same manner as the electric currents in a telephone correspond to the impinging sound-waves, is quite out of the question. There is more hope of seeing through the proverbial brick wall than of seeing through a copper wire. Such a conclusion may seem very unsatisfactory: it may damp many eager hopes. Nevertheless, there is no other conclusion possible in the present state of electrical science.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

SOME POINTS IN DYNAMO AND MOTOR DESIGN.*

BY W. B. ESSON, MEMBER.

(Continued from page 426.)

4. RATIO OF ARMATURE SECTION TO FIELD-MAGNET SECTION.

In the early days of dynamo-designing the cross-section of the armature core in cylinder machines was very small in proportion to that of the field magnets, the copper in the armature was excessive, and the air gap correspondingly great. The result was an induction no greater than in modern machines, but an enormous stray field. In the machines made by my firm six years ago, the section of the armature core was about one-third of the section of the magnets, the latter being of wrought iron. I may say these machines anticipated Mr. Swinburne's latest notions, inasmuch as the 14in. armatures of those days were loaded to 25,000 ampere-turns. The first great improvement consisted in doubling the iron and halving the copper, a machine so modified giving about the same output, but with less heating and less sparking, and requiring less magnetising force. We got the same output for two reasons: first, the decreased magnetic resistance resulted in an increased total induction; secondly, of this induction a far higher proportion was utilised. The ratio of the armature section to the magnet section, when modified as above, stood at ·66; but we went much beyond this in increasing the iron in the armature, finding that we obtained for every increase, keeping the air gap the same, an increase in the induction. The latter was not, of course, in proportion, but it was still very considerable, as will be realised from the fact that in an armature having a ratio of ·75 the induction was 10 per cent. greater than in one having ·6. When Mr. Kapp read his Paper here on "Characteristics,"† I mentioned that then the ratio in our dynamos stood at ·75. Since then we have, in machines for incandescent lighting, returned to ·6, for a reason which will be by-and-by apparent. It may be mentioned here that when the magnets are of cast iron the ratio is ·33, while the cast-iron yokes for wrought-iron magnets are from two to two and a-half times the area of the wrought iron.

I bring this forward because it is of some importance when the aim is to construct dynamos having a large output for their weight. The weight of the armature is only a fraction of the total weight of the machine. The field magnets are many times heavier, but, beside these, the bed-plate, bearings, &c., make up a large portion of the weight; and since the weight of neither magnets nor bed-plate is increased by an increased armature section, manifestly, if a large output for the weight is the object, and if nothing occurred to interfere with the process, the cross-section ought to be increased to such dimensions that for any further increase to the total weight of the machine we get no corresponding advantage.

Some interesting experiments to determine this point, which completely corroborate my own, were made by Mr. Dugald Jackson, of Cornell University, and communicated by him in 1887 to the American Institute of Electrical Engineers.‡ These experiments can be consulted by those interested; for the present my remarks are based on the results obtained. Assume that the iron core of a cylinder armature having a ratio of ·6 is one-tenth of the total weight of the machine: then, by increasing the ratio to ·75—that is, roughly, increasing the weight by 25 per cent.—we make an increase in the total weight of 2·5 per cent. But the increase in the induction will be about 10 per cent., so that clearly an advantage has been gained by increasing the section. If we increase the mass of the armature core by 50 per cent., it makes 5 per cent. increase in the total weight, but we get 15 per cent. increase in the induction. If we go farther we shall still get an increase, but it gets correspondingly less with each addition to the weight. The actual increase may not be in all cases in the proportion I have given. Necessarily it depends upon the design of the machine, but in the particular dynamo to which my remarks refer the results were as stated; and what I wish to point out is that in light-weight dynamos the armature must have a comparatively large section, and be worked at a lower saturation. Though the output for the armature weight is less, the output for the total weight is greater.

There is a limit to increasing the cross section of the armature, which is reached when self-induction troubles us by creating a tendency to sparking, and cross induction troubles us from the diminished saturation of the core. Accordingly the practical limit in this direction is fixed for us at about ·75, and the induction at 14,500 or 15,000 C.-G.-S. per square centimetre. It must not be forgotten that increasing the section of the core increases the length of the wire on it by a small percentage.

Pressing the induction up to high values is not advisable, as the magnetism then costs too much. It will be seen from the curve (Fig. 1) that the magnetising force to produce an induction of 18,000 per square centimetre is about twice, while the magnetising force for 20,000 is more than six times, that required for 17,000.

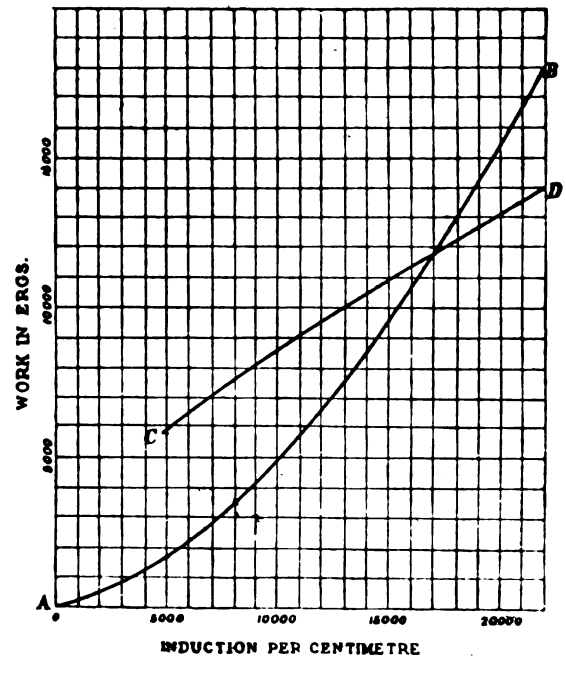


FIG. 14.

As the core saturation is increased the stray field is increased, while the heating due to hysteresis is also greater. Everything considered, 17,000 per square centimetre is probably the best degree of saturation to employ for cylinder armatures, and makers who once employed a greater induction are, I believe, coming down to this. If we work lower we get on the bend of the curve, or on that part where the angle changes rapidly; so that it is not possible to obtain in compound machines with a lower induction such perfect regulation. It may be mentioned in passing that, since the loss of potential in the armature and series winding is generally in slow-speed machines a higher proportion of the E.M.F., in these the difference in the induction on open circuit and at full load is proportionally greater, and the compounding, in consequence, less perfect.

There is no particular advantage in reducing the induction, save that of obtaining a higher weight efficiency. The reduction of the loss due to hysteresis is very small, and less than might at first sight be imagined. In Fig. 14 is given a curve, A B, showing the energy in ergs required to carry a cubic centimetre of iron through a complete cycle of magnetisation at different degrees of saturation. Induction per square centimetre is measured by abscisse, and the energy by ordinates. It will be observed that for 17,000 the energy is greater by about 24 per cent. than for 15,000; but for an armature of given output the cross-section of the core has to be increased in proportion as the induction is diminished, and the total work expended in carrying the armature through a cycle of

* Read before the Institution on February 20, 1890.

† Nov. 11th, 1886. See *Journal* Soc. Tel. Eng., Vol. XV., p. 548.

‡ *Electrical Review*, Vol. XX., p. 573, 1887.

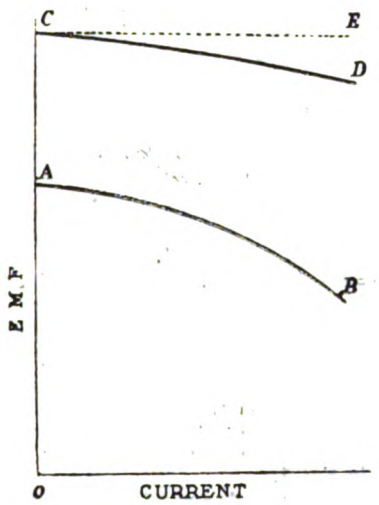
Digitized by Google

magnetisation is, roughly, proportional to the ordinates of the curve C D. To draw this curve an induction of 17,000 is taken as the normal, and all the ordinates of A B multiplied by the ratio of 17,000 to the induction. It will be observed that for any specified output there is only about 8 per cent. more power wasted in hysteresis at an induction of 17,000 than at 15,000.

In four-pole machines it is usual to saturate the armature to a lower degree—about 14,000; and in alternators the induction is still less—about 6,000. As the curve A B gives energy in ergs, the watts expended in the armature are found by multiplying this by the number of cycles per second and by the number of cubic centimetres in the armature, and dividing the product by 10^7. In drum machines the induction per square centimetre is rather over half of the value given for cylinders, and the ratio of armature to field section varies from ·8 to 1·0. The diameter of the armature being fixed with reference to the number and size of conductors, there is nothing to be gained by cutting away the interior of the washers. On the contrary, by cutting an opening only large enough for the shaft, the induction is kept low, and the magnetising force for the armature correspondingly small, while the heat generated due to hysteresis is also diminished.

5. Interference of the Armature Field.

Though iron may vary in quality, and so upset occasionally our calculations, no great difficulty need be experienced in approximating pretty closely the magnetising force required for a given induction in the armature core. But when we allow a current to flow in the coils, and so magnetise the core, we superpose on the original a second field and the interference between them renders the case no longer simple. If we excite the field magnets of a dynamo with a constant current, and allow currents of various magnitudes to flow



C. D. Strong Field.
A. B. Weak Field

Fig. 15.

through the armature, we find on maintaining the speed uniform that the E.M.F. falls as the current is increased. In 1884* some investigations of mine were published which dealt with this question, and established the result that when the ampere-turns on the armature were few, and the field strong, the fall of E.M.F. with a fixed load was about proportional to the current. As the field was weakened the line representing the E.M.F. began to bend, until, when it was very weak, a kind of inverse characteristic was obtained, as shown in Fig. 15. In fact, the results are similar to those which would be obtained by reducing the winding on the magnets; the effect due to this being small when the magnets are fairly saturated, and large when they are far from saturation. It was then observed that the Hefner von Alteneck winding produced least weakening effect on the field, while the now defunct Bürgin produced most, the Gramme taking a position between these two. Since that date electricians have talked frequently of the weakening effect on the magnets of the current flowing in the armature; but though it is admitted that the induction is the resultant of the magnetising forces both on magnets and armature, the conditions determining this resultant are by no means clearly comprehended.

Consider the magnetic system shown in Fig. 16. N and S are the North and South poles of a field magnet, the magnetising currents flowing into and out of the paper as shown by the open and crossed circles respectively. There is no current flowing in the armature coils, and the lines of force flow from pole to pole through the core as indicated by the dotted lines. Imagine that the current flowing round the magnet is stopped, and that a couple of brushes placed on the collector at S N (Fig. 17) cause a current to flow through the armature winding alone. We have the lines along paths indicated by the dotted lines, and obviously through this circuit at right angles to the other the cross induction depends, for a given number of ampere-turns, mainly upon the length and cross-section of the air gap. If we place the brushes at right angles to this position, we have no cross induction, but, instead, an induction taking the same path as the forward induction, though in an opposite direction. If the current is allowed to flow through field and armature coils at the same time, as it does in actual machines, we have the distribution of field as sketched in Fig. 18, the lines of force due to the magnets being pushed towards the left-hand top corner and right-hand bottom corner of the poles. Where the armature or cross-induction opposes the magnet or forward induction, the field in the air gap is weakened; where the cross

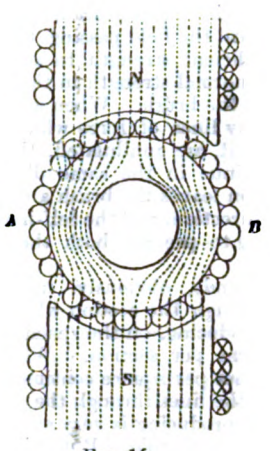


Fig. 16.

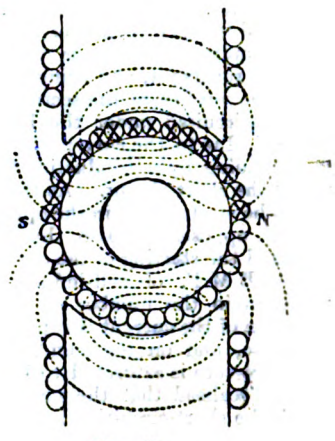


Fig. 17.

induction helps the forward induction, the field is strengthened. In consequence of this distortion with reference to the brushes, the sections under them have become active, and to avoid sparking a

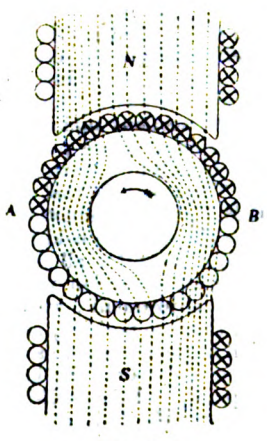


Fig. 18.

lead must be given, which will remove the commutated sections beyond the sphere of activity. This lead diminishes the forward induction, at the same time diminishing the distortion with reference to the new position of the brushes.

6. The Effect of Distortion on the E.M.F.

The distortion of the field produces in a dynamo run without lead a diminution in the E.M.F., for two reasons—first, because the induction acts differentially on the conductors lying between the brushes; secondly, because the currents flowing in sections active when short-circuited under the brushes weaken the field. These local currents induce lines in the opposite direction to the forward induction.

Let the machine run as a motor in the opposite direction, the currents flowing through the field-magnets and armature being of course in the same direction. The E.M.F. is induced in the armature in the opposite direction, and since in an active coil short-circuited under the brushes the current will flow in the direction of the induced E.M.F., its effect will be to directly strengthen the

* "The E.M.F. of Dynamo Machines Excited by a Constant Current," *Electrical Review*, Vol. XIV., p. 303. 1884.

Digitized by Google

field as it increases the forward induction. We may say, then, that the effect of distortion is to diminish the E.M.F. in a dynamo run without lead, and increase it in a motor, owing to the local currents generated in the short-circuited coils.

The difference in the E.M.F. of a machine run without lead as dynamo and motor may be considerable, as shown by Prof. Ayrton's experiments at the beginning of last year.* These experiments were made on a drum machine which had a comparatively weak field. I am not quite certain as to whether the cause here given is sufficient to account for the difference, but I believe that were the brushes adjusted in each case until the local currents were annihilated, the same E.M.F. would be, with properly laminated armatures, generated by both dynamo and motor. That there is a certain amount of power wasted in these currents is quite obvious, though from their tendency to lessen the distortion in the motor, their magnitude, and the consequent waste, is in the motor less.

7. Position of the Brushes in Dynamos and Motors.

If dynamos are to run sparklessly there must be a lead given to the brushes, or, in other words, the point of collection must be advanced in the direction of motion until the field passing through the commutated sections is just of sufficient strength to stop the current, reverse it, and bring it to its normal strength in the opposite direction before the section leaves the brush. When a section is short-circuited under the brush, any lines of force which were induced, due to the current flowing in it, are annihilated, the current tending by self-induction to continue in the same direction round the short circuit. As the section leaves the brush a current has to be started in it in the opposite direction, and the self-induced E.M.F. opposes this also, thus tending to prevent both the stopping and the starting of the current.

The E.M.F. of self-induction depends, obviously, upon the variation in the number of lines through the section which the cessation of the current is capable of producing, on the speed of the armature, and on the number of turns per section. When an armature core is saturated to 17,000 lines per square centimetre, it will be realised that the variation in the lines through the section which the short-circuiting is capable of producing is very small; in fact, we may say that it is practically negligible. But, with the smallest amount of self-induction present, it takes a certain time to effect these changes in the section, and the brush must be of such thickness that the changes are effected before the short-circuit is removed. The brush must be placed in advance of the neutral point: in an armature, for instance, having 50 sections, presuming that 5 volts are wasted in the armature, a section when it leaves the brush must move in a field having such strength as will neutralise the effect of self-induction, and give one-fifth of a volt over. If the armature has 100 sections, the field must give a resultant of one-tenth of a volt; but the E.M.F. due to self-induction will be in the latter case only one-fourth of what it was in the former. By saturating the core, and making the sections sufficiently numerous, we can make the self-induction as small as we please; and in machines in which the current varies from 0 to a maximum, we purposely make it as small as possible. The reason is, that as the current increases, the variation in the E.M.F. of self-induction does not correspond with the variation in the shape of the field for different positions of the brushes, perfect adjustment for all currents being therefore difficult. By making the self-induction very small we get a close approximation to perfect adjustment; we can place the brushes very little in advance of the zero position, reducing in this way the adjustment for variation in the current to a minimum.

We see, then, that in a dynamo the brushes must be set in advance of the neutral point, and that self-induction increases the lead. Is the trail in a motor similarly increased? The answer is that it is. The brushes must be set in a motor behind the neutral position, so that the induced E.M.F. is in the same direction as the current to be started in the section, and so that the E.M.F. of self-induction which opposes the starting is neutralised. It appears that the best position for the brushes in a motor is the position in which they have about the same trail as they have lead when the machine works as a dynamo, and that in a motor the trail is *increased* by self-induction.

(To be continued.)

International Exhibition at the Palais de l'Industrie.—The Société Nationale des Sciences et des Arts Industriels are preparing an Exhibition to be held in Paris this summer, at the Palais de l'Industrie. The Exhibition will be open from July to November; Class 20 will include batteries, dynamos, &c., and Class 21 telegraphic and telephonic apparatus.

* *The Electrician*, Vol. XXII., p. 404, 1889.

THE ZIPERNOWSKY-DERI-BLATHY SYNCHRONOUS MOTOR.*

A synchronous motor is set in motion by an alternating current sent through the armature, and when working under normal conditions the number of revolutions is equal to the number of alternations. An alternator, the magnets of which are excited by a direct current, can be used without difficulty as a synchronous motor; but the alternator must be brought to synchronism before it will work. The magnets of a synchronous alternating motor can be excited by an alternating current; for this purpose a revolving commutator is necessary to give the requisite direction to the current impulses in the magnets. In its simplest form such a commutator consists of as many segments as the motor armature contains coils, the even segments being connected to one another and to one end of the magnet coils, whilst the odd segments are also

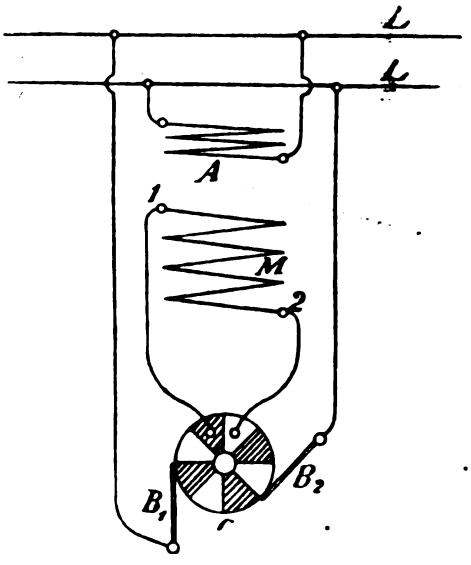


Fig. 1.

L L = Leads. A = Fixed armature. M = Maguet coils. B_1 B_2 = Brushes.

connected to each other and to the opposite end of the magnet coils. If the brushes are given the proper position it is evident that (supposing the motion to be synchronous) each time the current changes its direction the connections to the magnets will be reversed, so that the magnets are excited by a uni-directional intermittent current. A diagram of the essential parts of such a motor is shown in Fig. 1.

In a motor with fixed magnets and rotating armature two additional pairs of sliding contacts are required to supply the armature with current and to take the current off the commutator to the magnets. Motors arranged as above can also be started by an alternating

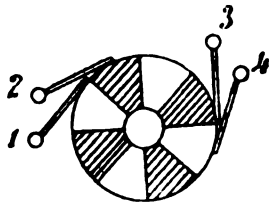


Fig. 2.

current, but the iron of the field-magnets must be protected against Foucault currents. When in such a motor a favourable position is given to the armature and the magnets (or a slight motion imparted), an alternating current will start it, and the speed will increase until it is running synchronously; but practically such a machine is useless on account of sparking, both during the first motion and at full speed.

It is this difficulty which Zipernowsky, Deri, and Blathy claim to have overcome. The sparks are caused by the extra currents induced at each alternation. The current is only strong enough during part of the period to keep the magnets sufficiently magnetised, and when the strength falls off an extra current is induced in the magnet coils. At this moment a path of low resistance is provided and then immediately broken again. Sparks are the result. The intensity of the fields also undergoing great fluctuations, the speed of the

* From the *Elektrotechnisches Echo*.

Digitized by Google

motor is very uncertain, and it easily falls out of synchronism. All this is overcome by short-circuiting the magnet coils a short time before the reversal of the current, the brushes being so arranged that at the moment of segment-change the extra current acts in opposition to the main current, getting rid of the sparks. The momentary short-circuiting is effected by employing four brushes, which are connected as shown in Fig. 2; 1 and 2 being connected with one lead, and 3 and 4 with the other, the magnet coils being short-circuited during the time that the brush 2 is on the shaded segment. The distance between the contact points of the brushes 1 and 2 is $\frac{1}{4}$ to $\frac{1}{2}$ of the width of a commutator sector. It is, of course, not necessary that the brushes at one end of the conductor should be on the same segment, as they may be on different segments of the same class, as shown in Fig. 3, the effect being the same; or, instead of two separate brushes, one with a broader bearing surface may be used. Numerous tests show that with this arrangement of short-circuiting the brushes sparking at the commutator is obviated, and the motor runs synchronously.

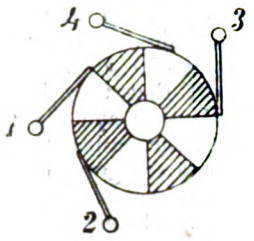


Fig. 3.

The above arrangement is perfectly satisfactory when the motor has attained the synchronous speed; but starting is difficult, and the torsional moment being small, the normal speed is not quickly reached. At starting, a slight displacement of the brushes is necessary. An arrangement has therefore been adopted by which one brush of each pair, 1 and 3 or 2 and 4, may be cut-out at starting, or both of each pair 1 and 2 and 3 and 4 are brought to the same respective segments, so that no short-circuit occurs. As soon as synchronism has been reached, the arrangement permits the other two brushes to be brought to the positions shown.

The short-circuiting of the magnet coils may also be effected by the use of two commutators side by side, the segments of which overlap each other (as shown in Fig. 4), to the extent required to bring about the requisite short-circuiting. The necessary removal of the short-circuiting at the start can be brought about either by taking away the short-circuit brushes or by the automatic arrangement shown in Fig. 5.

To prevent too great an increase in current during the short-circuiting, a resistance is provided in the circuit. The same object is gained by using an induction coil, the windings of which are connected to the armature and the magnet coils respectively. The induction prevents a too great increase in current (Fig. 6).

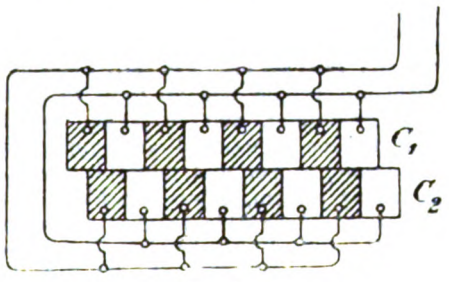


Fig. 4.

This motor has been put up in various places, among which may be mentioned—Wiener Neustadt, three motors of 10 horse-power, and Innsbruck, one motor of 50 horse-power, one motor of 10 horse-power, and one motor of 5 horse-power.

The following abstract of the report of the Committee recently appointed by the Town Council of Frankfort-on-Main to inquire into the alternating and direct systems of distribution will be of interest in this connection.

On the question of the output and efficiency of the Ganz alternate-current motor, the Committee report that experiments were made with the 25 horse-power and 5 horse-power types. The former gave efficiencies of 82 per cent. to 88 per cent. for outputs of 15 to 35 horse-power; the 5 horse-power showed efficiencies of 60 per cent. to 80 per cent. for outputs of 3 to 8 horse-power, the figure for normal load being on an average 78 per cent. The efficiency, therefore, does not differ to any important extent from that of direct-current motors.

With respect to starting, it was found that the 25 horse-power motor could not start itself, and the smaller sizes, 5 horse-power and $\frac{1}{3}$ horse-power, were unable to do so in certain positions. A test as to starting the motor with full load on was not made, as Messrs. Ganz and Co. objected to it. The time necessary for the attainment of normal speed was from 30 to 45 seconds. The start was always accompanied by heavy sparking at the brushes, diminishing as the normal speed was reached. In the 25 horse-power machine these sparks were 5cm. long, and 3cm. on the 5 horse-power machine. At normal speed the sparking was not worse than with direct-current motors.

With regard to noise, the Committee pointed out that from the nature of the action, as well as from the sparking, when not running synchronously more noise was to be expected from the alternating-current machine. In factories and on tramcars this noise was unimportant; but it would exclude the larger sizes of the

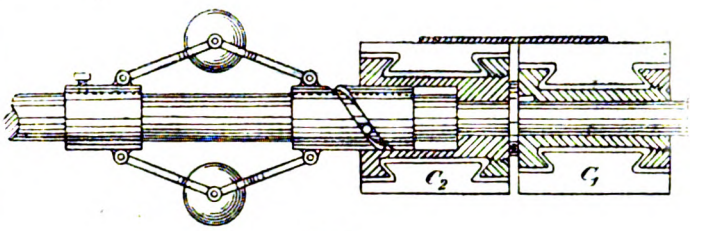


Fig. 5.

motor from dwelling houses, unless exceptionally good foundations were secured. With the small motors the noise would not exceed that of the machines used to drive sewing machines with. The motors being synchronous, regulation of speed could only be arrived at by means of multiple-speeded pulleys.

A series of tests was made to ascertain the effect of sudden application of load and of overloading, and it was found that the 25 horse-power motor did not fall out of synchronism till it was loaded with 40 horse-power, and the 5 horse-power motor could be loaded up to

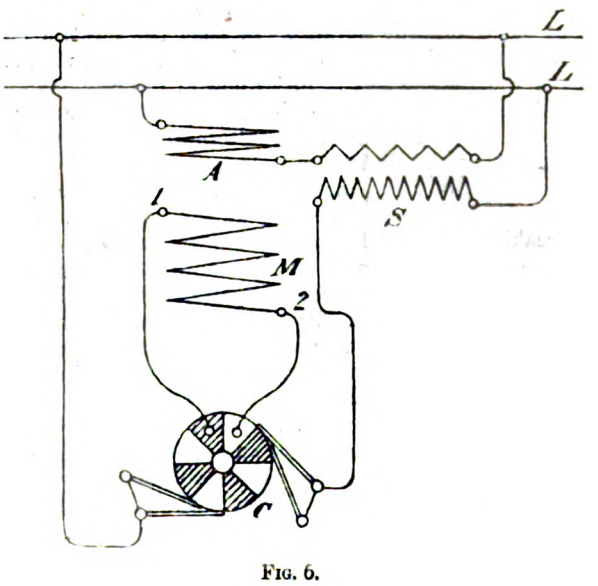


Fig. 6.

8 horse-power, in each case a maximum load 60 per cent. in excess of the normal. A sudden load of 26 horse-power can be put on to the large machine when running light, though a heavier load than this suddenly applied will cause it to stop. When running at 26 horse-power a further sudden load of 8 horse-power, and after the application of this a further 6 horse-power, can be put on, the total load being then 40 horse-power. The whole of this load can be suddenly removed without affecting the behaviour of the machines. The 5 horse-power machine could take a sudden load of 6 horse-power, which in the same way could be suddenly increased to 8.

These tests show that the normal output must be kept well under the possible maximum, or, in other words, that a considerable margin must be allowed in settling on the size of machine to be employed. It should be mentioned that the machines tested were the second of their respective classes that had ever been made.

Digitized by Google

THE WEYMERSCH BATTERY.

A demonstration of the capabilities of the Weymersch battery for electric lighting on a small scale is now being made at the offices of the Weymersch Electric Battery Syndicate at 2, Victoria-mansions, the offices of the Syndicate being lighted by several incandescent lamps, and a 400 candle-power Planet arc lamp run off Weymersch cells. The Planet lamp is run directly off a battery of 30 cells, and works very satisfactorily. M. Weymersch's depolarising solution is sold at one shilling per gallon, from which quantity of liquid about 1000 watt-hours of useful work may be obtained under ordinary working conditions; so that a 30-watt lamp can be run off this battery at a cost for depolarising solution of about ½d. per hour, or about ¾d. per hour taking everything into account. A full description of the Weymersch battery appeared in *The Electrician* of June 28, 1889; and Messrs. Alabaster, Gatehouse and Co.'s report will be found in *The Electrician* of June 22, 1888.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *February* 22, 1890.

Meeting of the National Electric Light Association at Kansas City.—The National Electric Light Association has just held, at Kansas City, its 11th semi-annual meeting, with so large an attendance that everyone interested in the Association is well satisfied at the results of the somewhat risky plan of holding a meeting in the winter in the south-western corner of the country, remote from the homes and businesses of a large majority of the members. The papers that were read were, with few exceptions, of the usual practical nature. One of the most important presented was that by Prof. Elihu Thomson, who took up the subject of "Safety and Safety Devices in Electric Installations." In this Paper Prof. Thomson took the trouble to point out that while we all know that the electric current may be a source of danger to life and property, it may also, by means of the devices and facilities now at the command of the electrical engineer, be made thoroughly safe. The question is not one of direct current or alternating, low tension or high tension, overhead wires or underground wires, but belongs to the province of right methods, and the use of such insulation and other protective devices as will prevent the service from breaking down or developing dangerous conditions. With regard to subway circuits he advanced a somewhat novel theory to account for the recent explosions of which we have had so many in New York City. A heavy leak or overheating, he says, occurring at some point of the conductors near the manhole may generate directly a large volume of inflammable gas from the distillation of asphaltum or other substance used as an insulator; and this gas, mixing with the air of the manhole, may be easily fired by the heat of an arc or spark subsequently to its production, and cause a violent explosion. The remedy is thorough and continuous ventilation of the spaces in the manholes and subway. With regard to interior wiring, he approves such methods as those recently worked out by the Interior Electrical Conduit Company, as described in my letter some time back; and with regard to methods of incandescent light distribution he deemed such to consist in a "properly arranged double wire cable, well insulated, constituting the primary line, laid in ventilated pipes underground, transformers connected therewith, also enclosed in a grounded metal case, in the cellar of a building, and a secondary line of low potential grounded or provided with safety devices, as mentioned."

Another subject that was taken up was that of mutual insurance, on the lines of the new company to which I have previously alluded. Attention was called to this scheme by the report of the committee on the subject, and it is now understood that already some 49 stations, representing an insurance risk of upwards of one million dollars, have signified their approval of the plan, and their willingness to co-operate. So large a guarantee insures the success of the scheme. In connection with this subject it was proposed in the Association that a committee be appointed to see if, following the example of various sections of the country, a set of uniform rules for insurance could not be adopted and enforced all over the States, so that the work would be of equal standing and efficiency everywhere. Such a committee, working in connection with the insurance people, would constitute a body to which could be referred important questions for final adjudication, and its careful work would be of vast benefit. The idea was generally approved, and it is probable that something of the kind will soon be attempted.

Another subject of general importance which was brought up was that of potentials for electric railways, this being a matter in which not a few electric light companies are directly interested, and which is to be considered by the officers interested in electric railway enterprises. With regard to potentials now in use, the committee said that they found them to vary from 220 to 800 volts. The greater number of companies, however, reported using a potential between 450 and 550 volts. The committee were glad to be able to report that they had written authority from both the Thomson-Houston and Sprague electric railway companies to make a statement on behalf of their respective interests, that they will hereafter agree to use a standard potential of 500 volts upon all electrical street-railway equipments that do not require any special apparatus for their successful operation. The committee recommended the electric light companies to add to their regular business the furnishing of power to street railroads, but wish it distinctly understood that they do not base any hopes of profit on the old idea that the same machinery could be used for furnishing light, heat, and power in the daytime. Their suggestion is, that while the station itself may thus be in continuous operation all the time, different sets of apparatus, specifically built for the work it is intended to do, should be provided. A great saving for the central stations would lie in the reducing of labour and fixed charges over the whole work, and in the fact that the reserve power for the one service, though not the plant actively engaged, would suffice for the other. It appeared from the report of the committee, that, so far, only nine of the electric light companies had been enterprising enough to agree to supply the street-railway companies with their power, although in nearly every case where the railroad had been put into operation, there was, at least, one central station that could well have contracted to supply the necessary current.

A very interesting address touching upon the electric railway subject was also delivered by Mr. Frank J. Sprague, who made a rapid review of the work done during the past two or three years, and then went on to discuss one or two of the leading questions now agitating the electrical community. One of these was the interference between the telephone, electric light, and railway interests, Mr. Sprague contending that the telephone people had no right to a monopoly of the earth for grounding, and that, as the electric railway service had been sanctioned and approved by public authorities as a safe, proper, and desirable method of travel with a single trolley system, it was not likely that the telephone companies would be able to check the progress of the new industry. He showed how the electric railway companies had already won several contests, and remarked that, with the records thus gained, it would seem that the electric railway companies had little to fear from the telephone interests, being well within their rights. At the same time he suggested that in a great many instances reasonable and satisfactory methods of compromise might be resorted to. With regard to the future Mr. Sprague remarked that we had already got beyond the stage of operating three or four cars in the street, and even beyond that of running 40 or 50 cars from the central station, the next step being the providing of such systems as the underground railway of London or the elevated railways of New York. With regard to the trunk line service, he went into a very interesting discussion, and made the rather striking point that for running between New York and Philadelphia, for instance, the aggregate of the copper already in use for the long-distance telephone service is 40 per cent. more than the weight of two copper rods an inch in

Digitized by Google

diameter for electric railway service running between the two cities! "If the investment is a reasonable one in the telephone system," he says, "cannot we consider it a reasonable one in that larger field of transmission of power of which we are now speaking?" He then went on to discuss the probabilities involved, and led up to the conclusion that it would be thoroughly practicable to operate a 60-mile express service every ten minutes between New York and Philadelphia, instead of a 40 or 45 miles' service every hour. Such a change would revolutionise travel, and would develope a great many conveniences of a kind now undreamt of. In the subsequent discussion, Mr. Sprague made a statement that he and some friends of his had recently invested in an electric road in the South, and that they had also bought up the electric light interests, and consolidated the elements of manager and *personnel*. He thought it possible they might even control the telephone interests, and they propose to run the telephone wires on the same poles with all the other circuits. "We are going," he said, "to demonstrate that it is quite possible to run the telephone circuits and the electric railway pole line not only in conjunction with it, but in conjunction with electric lights and incandescent lamps. We hope this enterprise will be profitable, and that there may be a great many other places in which the same thing may be done."

Two very interesting Papers were presented on the subject of arc lighting, one on "How to make Arc Light Circuits Safe," and the other, by Mr. Law, entitled "Nine Years with the Arc Lamp." There was a third Paper on a kindred subject, that by Mr. Peck, on "Carbon Tests." Mr. Law in his Paper showed how desirable it was for station superientendents and managers to study out their lamps in their details, and to see where they could make little improvements for themselves with the result of greater efficiency in service and economy in construction. Mr. Law touched upon many points that may seem small, but yet are important; for example, he said the waste in the use of carbon is a very important feature. These should be dealt out, and every stump returned. The amount saved in laying by the four or five inch stumps to be used in the summer months will make a saving of at least 10,000 carbons per year for a 1,000-light station. At the time he first started dealing out carbons and bringing in stumps he saved on an average over $30 per month, and then only trimmed about four hundred lamps per day. In the Steam Engineering Department, two or three very interesting Papers were presented, including those by Mr. G. H. Babcock, on "The Economical Generation of Steam for Electric Light Stations"; Mr. C. J. Field, on "The Brooklyn Edison Station"; Mr. C. J. H. Woodbury, on the "Construction of Central Stations," and Mr. F. Sickels on "The Steam Engine," the last named author, as some of your readers may know, being one of the predecessors and competitors of Corliss, well known from his connection with the trip cut-off valve which has now been before the public for well nigh fifty years. The most important part in Mr. Field's Paper, apart from his statements with regard to the Brooklyn Edison station, which I have already noted in my letters, was his reference to the triple expansion engine imported from France by Mr. Edison.

Two other interesting Papers were those presented by Mr. A. J. De Camp and Mr. T. C. Smith, on the subject of "Central Station Accounts." There were a number of other topics touched upon, but I have mentioned enough to show the range of useful discussion.

CORRESPONDENCE.

TESTING GALVANOMETERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR,—Messrs. Elliott Bros.' letter in your issue of February 21st is written in such very questionable taste that it appeared to me undesirable to answer it. It has, however, been pointed out to me by several of my friends that my not replying may perhaps mislead those who are not acquainted with the particulars into imagining that there is some foundation for Messrs. Elliott's criticisms of my remarks made at the Physical Society.

As someone has been good enough to draw your attention to certain errors in your report of the meeting of the Physical Society, published in your issue of February 14th, and as you have already published the necessary corrections, it is now obvious that the first half of Messrs. Elliott's letter is a criticism of your reporter and not of my remarks themselves.

In the second half of their letter they make the following statement:—"For the last 25 years at least it has not been customary to use any other cell than the Daniell's in testing for the figure of merit." As far as it concerns their own practice, I have the following certain reason for knowing that this statement has been made by Messrs. Elliott under some serious misapprehension:—Some four or five days before my departure for India, which took place on December 26, 1868, I went by appointment at about four o'clock in the afternoon to see tested an astatic reflecting galvanometer which Messrs. Elliott had constructed for me. On entering, in company with the late Mr. Becker, a small room which was near the front door in Messrs. Elliott's former premises in St. Martin's-lane, there stood on a table against the wall on the south side of the room the galvanometer set up ready for testing, the scale and lamp in position, and between them was a Grove's cell, the porous pot of which, containing the platinum, had been temporarily removed and put into another vessel by the side on the table. While Mr. Becker was turning up the wick of the paraffin lamp, which stood on the scale at the west side of the table, I mentioned to him that, although in the specification that one cell through so many megohms was to give no less than such a deflection, it had not been expressly stipulated that the cell to be used was to be a Daniell's cell, I had certainly understood the specification in this way. He replied, however, that they always used a Grove's cell in testing galvanometers. The whole incident has been ever since very firmly fixed in my mind, as it gave me my first lesson regarding the necessity of minute detail being inserted in specifications to avoid misunderstandings.

It is, therefore, quite certain that, at any rate, 21 years ago it was Messrs. Elliott's usual custom to employ a Grove's cell, and not a Daniell's, in the testing of a galvanometer; and it was on this account that I asked Mr. Mather in January last to write to Messrs. Elliott regarding their tests of one special galvanometer constructed a long while ago, and the maker and tester of which were, I understood, both dead.—Yours, &c.,

W. E. AYRTON.

SECTIONAL CONDUCTORS FOR ELECTRIC TRAMWAYS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the last issue of *The Electrician* there appears a report, drawn up with a great flourish of trumpets, by three English engineers, on a system of sectional conductors for electrical tramways, which is called "The Wynne Electric Tramway System," by means of which "power is transmitted from the engine to the car as directly as by rope traction without the objectionable necessity of cutting a continuous slot in the roadway." It is mentioned in the editorial remarks on this American system that it does not possess that startling novelty Mr. Wynne and the reporters imagine; but it is not stated that the detailed methods described by Prof. Perry and myself in our patent specifications Nos. 783 of 1881, and 2,395 of 1883, were originated for carrying out several years ago, *by practically exactly the same means, the precise idea* that constitutes Mr. Wynne's invention of 1890; and that therefore, in the expressive language of his country, his proposal is a "chestnut."

The system is for the purpose of working even a long electric tramway, or railway, without the necessity of having either:—

1. The leakage from rail to rail that occurs with a line like the Brighton Electric Tramway.

2. Or an overhead insulated bare conductor rubbed along its whole length by a carrier pulled along the moving car—the system now commonly adopted in America.

3. Or a well-insulated conductor raised a few feet above the ground, and rubbed by a shoe attached to the moving car, as at Portrush.

4. Or a continuous slot on the road, as at Blackpool.

Digitized by Google

The former of the two patents mentioned above, viz., that for 1881, covers and describes methods for attaining this result by the use of:—

"Our improved apparatus consists of an insulated wire, cable, or other conductor or conductors, placed either alongside, above, or underneath the railway, or in any other suitable position, and the insulation of which is maintained by gutta-percha, india-rubber, &c., or by paraffin or other oils, or by its being supported on insulators. This conductor, or conductors, is automatically, or at will by a signalman or other person, electrically connected successively to one or more sections of a rail in the neighbourhood of the moving train. This rail, which may or may not be that on which the train moves, and which may be rigid or somewhat elastic, is divided into sections fairly well insulated from one another and from the earth, &c."

Then it is explained that the insulation of a conductor on the ground, as, for example, the ordinary rail, is sufficient in certain cases to enable it to be used as the sectional conductor, "dividing and insulating the said rail at the usual fish-plate or other joint into sections of suitable length."

The devices described in detail in the 1881 specification for automatically connecting the main well-insulated cable with the various sections in succession of the rubbed conductor are worked mechanically; but, quoting from the patent:—"We do not restrict ourselves only to the specified means of effecting contact between the rubbed rail and the well-insulated conductor, inasmuch as our improvement consists essentially in employing only a short part or parts of the sectionally-insulated rubbed rail as conductors at any one time, viz., those to which the travelling carriage is nearest." Further on, this specification states, "Instead of the mechanical plungers we may use electric means for this purpose . . . or we may employ a magnetic arrangement depending for its action not on the weight of the train, but on its magnetic mass." This latter is the plan *subsequently* brought out by Mr. Binswanger, and published some three years ago.

The second of our two patents referred to above, viz., 2395 of 1883, the provisional specification of which is illustrated with 24 drawings, and the final with 31, is wholly occupied with descriptions of numerous methods for carrying out Mr. Wynne's idea of automatically, or at will, making a connection *electro-magnetically* between the well-insulated conductor and one or more of the sections of the rubbed conductor which are in the neighbourhood of the moving train.

This specification even describes, in the following words, Mr. Wynne's device of using a battery carried on the moving car for re-establishing contact between the well-insulated conductor and the sectional conductor:—

"For this reason we prefer for railways on the ground not to replace our automatic mechanical contact makers by electrical contact makers operated by the mere short-circuiting action of the wheels or brushes on the train, but instead a current—to use accumulators, or a battery, or a small magneto or dynamo machine on the train to operate the contact maker; or, lastly, to arrange that the short circuiting of two things at any contact-box can only put current on to a section if the current has already been supplied to the previous section—that is to say, although the successive short-circuiting action produced by the train at each contact-box will, in succession, connect the next section with the main supply cable, and disconnect the last section, the short-circuiting of certain things at any one contact-box at random will produce no effect whatever." And as a further proof of the striking similarity between our devices of 1883 and Mr. Wynne's of 1890 we may quote the following, which occurs in the same specification after the account of the detailed methods adopted for working the contact-boxes by the battery carried on the train:—

"It is to be observed that although a train which has been at rest in any section can by one application of the battery it carries cause at will the main supply cable to become connected with that section, and as it proceeds along it can, without any further application of the battery, connect the supply cable with every section in succession, disconnecting it in succession from every section left, no mere random short-circuiting of the end and beginning of the rails of any two sections, or of the insulated and earth rail of any one section—by means of a crow-bar, for example—can produce any effect at all."

In the report on Mr. Wynne's system, stress is laid on the fact that by connecting two adjacent sections in parallel with the rubbed conductor, so that the circuit through one section and the motor on the train is closed before the circuit though the section behind is broken, Mr. Wynne obtains an arrangement which "effectually obviates sparking." I have again merely to quote the following from our patent 783 of 1881:—

"When a carriage, or train, in the ordinary course passes from one section to the next, whether going forwards or backing, the main current, as already explained, is put on to the section the carriage, or train, is entering before it is taken off from the section the carriage, or train, is leaving; indeed, it is not until the carriage, or train, has received the current on the section just entered that it is taken off from the section being left, and for a short time while the carriage, or train, is partly on one section and partly on the other, it is receiving current from both sections; and we have adopted this arrangement partly in order that the induced sparks or flashes that are usually produced in making or breaking an electric circuit, and which rapidly burn away the contacts, shall not be produced by our form of contact makers."

No one admires the go-aheadedness of the Americans more than I do; but, when an idea of pure British origin returns across the Atlantic with so strong a Yankee accent that it might well pass for having been born and bred in the States, one feels that that is going ahead just a little too fast.—Yours, &c.,

W. E. Ayrton.

THE WYNNE SYSTEM OF ELECTRIC TRACTION.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I should like to make a few remarks on the note in your last issue referring to my system of applying electricity to the working of urban tramways.

From your note it might be supposed that, having worked out a scheme on paper, I at once rushed into print; this, however, is very far from being the case, as, with your permission, I will proceed to show, and also to show that my claim to novelty is fairly well founded. The first patent dealing with rubbed sectional conductors is, so far as I am aware, Prof. Ayrton's, No. 783, 1881, in which he proposes using them for electrical railways for the expressed purpose of reducing leakage of the current, and he employs a sectional insulated rail made slightly elastic and furnished with mechanical plungers, through which, by the effect of the weight of the passing train, contact is made with the main insulated conductor. Dr. Hopkinson, in his patent No. 4,718, 1882, refers also to the use of insulated sectional conductors on electric railways for the same purpose of preventing leakage, and he employs the rise of potential caused by the car coming on the new section to make the connection between the main conductor and these rubbed insulated sectional conductors.

My first patent for applying electricity to tramways is dated April 9, 1883; and in that patent the special advantages of short-rubbed road-bars for electric tramways, as opposed to electric railways, is for the first time fully described, and the principle of using short lengths of sectional uninsulated exposed road-bars—charged successively—and short enough to ensure the ordinary traffic of the street being secured, by the protection of the car, from accidental introduction into the electrical circuit, is first developed; details are also given of an automatic electric system, whereby the short lengths may be successively charged from an insulated main conductor. Prof. Ayrton followed with his patent No. 2,395, 1883, for electric railways, being a continuation of part of his patent, No. 783, 1881, and describing a method of effecting the successive charging of his insulated sections ("a mile or more in length") by causing a momentary short-circuit as the train enters a new length. In my patent, No. 9,215, 1886, for electric tramways, I provide for an even greater subdivision of the rubbed road-bars than in my earlier patent, and amongst other things I show a contact-maker actuated by an electro-magnet carried by the car.

Digitized by Google

Messrs. Pollack and Binswanger, in their electric tramway patent No. 14,106, 1886, adopt my principle of making the rubbed road-bars short, and thus protecting the ordinary street traffic from contact with the charged sections; they effect the successive connection of these short road-bars to a main insulated conductor by means of an electro-magnet carried by the car, and which acts by induction on contact-makers in the roadway.

In my patent No. 747, 1887, or more than three years ago, I show another way of connecting these short protected lengths of road-bar successively to an insulated main. In this system there is no limit to the power available for making the contacts good.

For all the above inventions patents have been granted, both in the United States and in Germany, which may be taken as a fairly satisfactory proof of novelty.

Mr. Wheless, to whose system you referred, is, I submit, open to the reproach—if it be one—of having rushed into print with a Patent Office specification, his patent dating only, I believe, from the latter part of last year.

The question of possible trouble with so large a number of contacts forms the subject of a special paragraph in the report of the Brush Electrical Engineering Company's Engineers, lines 27-35 (page 427 of your issue of February 28th); and besides this I may refer to Sir Frederick Bramwell's report to the directors of the Series Traction Syndicate, and dated April 16, 1889, on a similar supposed difficulty in connection with the number of contacts in what is known in America as "The Short Nasmyth Series System." (*See* extract below.) There is no sparking whatever in my contact boxes My patent of 1886 was followed by long and complete trials on a full-gauge line at Messrs. Elwell-Parker's works; but nothing was published, as they resulted at the time in only partial success, although in a great deal of hard-earned experience.

Before submitting the system described in your last issue to the notice of the engineers of the Brush Electrical Engineering Company, I had profited by the criticisms of some of the best-known tramway engineers, whose advice I had the advantage of obtaining.

I wish it to be clearly understood that I do not make any criticism, favourable or unfavourable, on other systems; but I may mention that it was with a full knowledge of what I had done, and of what had been done by others, that the engineers of the Brush Company expressed the opinion "*that it is the only practical attempt that, up to the present, has been made to grapple with the real difficulties of urban electric traction.*"—Yours, &c.,

FRANK WYNNE.

5, Westminster-chambers, March 5, 1890.

Extract from Sir Frederick Bramwell's Report.

"As regards the probability of this electrical conductivity being maintained, no doubt it is a somewhat startling proposition that, at every 21 feet in a line of tramway, contact should have to be broken and made on the passage of every car. But also, if, up to this day, although clocks were well known, watches had never been used, it would be a startling proposition that a timekeeper on the principle of a clock could be made so that it could be carried in the pocket, and, while being thus subjected to all the jars and concussions arising from its wearer walking about, should nevertheless work successfully and keep good time. Yet, startling as this proposition would be, if made now for the first time, its daily practical fulfilment is looked upon as one of the commonest of accepted facts. Moreover, in the event of any spring-jack getting out of order, it is but the work of a few minutes to make electrical connection past it, with the result that the cars by their momentum travel over a section thus thrown out of use without appreciable loss of speed."

COST OF ELECTRIC TRACTION ON THE BARKING ROAD.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have delayed commenting on your remarks on my letter of 10th ult., in order to see whether any of your other readers would take up the subject. As, however, no letters have appeared, I beg to send you the following figures as forming the basis of my "scepticism."

As the average tractive effort required on the level, I have taken the figure usually adopted, 30lb. per ton. Considering that the Barking Road line, though fairly straight, has a number of sharp turn-outs for passing places, and that the rails are not in the best order, I am convinced that this figure will not be found too high by any means. Taking this value for the tractive force required, it will be found that a car is capable of travelling by its own weight down a slope of about 1 in 75. Therefore, on lighter gradients than this the extra work expended in going up hill will, theoretically, be compensated by a corresponding saving when going down; but on steeper gradients this compensation will not be complete, as to make it so we should have to make the action of gravity put back work into the accumulators. This, of course, is not done, and the consequence is an expenditure of work on up-and-down gradients exceeding 1 in 75, greater than the average. (I may mention that in practice extra average work is required on *all* gradients, not only on those on which the theory would lead us to expect it.) Now, on the line in question the following gradients occur:—200ft. of 1 in 66, 450ft. of 1 in 56, 360ft. of 1 in 40, and 325ft. of 1 in 36, all of which give rise to this increased demand on the accumulators. Making the requisite addition on this head, allowing 12 starts and stops on the double journey of 2½ miles (deducting an amount corresponding to the distance run after cutting off the current in stopping), I find that an accumulator car, weighing with an average load of passengers eight tons, requires for the 2½ miles an expenditure of 3,650,000 foot-pounds of work at the car axle, *i.e.*, ·737 horse-power hours per car mile.

Now, as to the efficiency of the system. That of the motor and gearing cannot be higher than 75 per cent., as a motor used for traction is, as a rule, working far below its normal capacity. That of the accumulators I put at 66 per cent., certainly as high as can possibly be expected for the high and variable rate of discharge called for. The efficiency of the dynamo may be put down at 90 per cent., and I allow 10 per cent. for loss in engine and belting. This gives for the efficiency of the system 40·5 per cent., and the ·737 horse-power hours necessary per car mile at the car require a production of 1·82 horse-power hours at the central station per car mile run. The cost of this, including coal, water, wages, depreciation on engine and sundries, is at 1d. per horse-power 1·82 pence. Depreciation on dynamos and switch boards at 7½ per cent. per annum will amount to ·085 pence per car mile, and drivers' wages to ·6 pence.

With regard to maintenance of accumulators and motors, I maintain that no reduction on the costs of these items at Brussels is possible. It is true, as you pointed out, that the Brussels line is more difficult than that at Barking, and also that the rate for renewals would be lower over here; but, on the other hand, it must be remembered that the Barking-road cars are much heavier and carry more passengers than those in Brussels. Then any expectation of effecting a saving by using English plant cannot come to much in view of the fact that the motors ultimately used in Brussels were supplied by an English firm, and that Julien's accumulators were soon discarded in favour of the Faure-Sellon-Volckmar cells.

Adhering, then to the figures originally given, the minimum cost for electric traction on the Barking Road must amount to over 5d. per car mile, made up as follows:—

	d.
Steam power, including depreciation on engine and wages	1·82
Depreciation on dynamo, &c.	·085
Drivers' wages	·6
Maintenance of accumulators	1·5
,, ,, motors	1·0
Total per car mile	5·005

without counting interest on capital.

I am aware that it has been stated that figures can be used to prove anything, but in the absence of facts, I think we are justified in relying on figures if they are put together with some regard to common-sense.

Apologising for the length of this letter,—Yours, &c.,

H. J. S. HEATHER.

18, Stanley-road, Wimbledon, March 1, 1890.

[As our correspondent rightly observes, figures may be made to prove anything, and the following figures, derived from a

Digitized by Google

letter of Mr. A. Reckenzaun's, which appeared in *The Electrician* of August 23, 1889, illustrate this very well :—

	Pence per car mile.
Renewal of accumulators	1·0
,, ,, motor and gearing	·75
Cost of fuel, attendance, maintenance and depreciation of the engine, boilers and dynamos, at the charging station	1·64
Total	3 39
Adding for driver's wages, according to our correspondent's estimate	·6
We get	3·99

A difference between our correspondent's figures and those of Mr. Reckenzaun of over one penny per car mile.—Ed. *E.*]

THE LIFE AND EFFICIENCY OF GLOW LAMPS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In reply to Mr. C. J. Robertson's question, I may say that the pressure at the lamps never falls below 98 volts or exceeds 100 volts. The latter E.M.F. is the usual difference of potential. I have hundreds of lamps which have run over 3,000 hours. The one selected for your contemporary was merely a chance lamp, and not a picked one. I attribute the length of lamp life here entirely to my method of obtaining constant E.M.F. (within 1 per cent.) on the lines; and the results have far exceeded my expectations. I find by a Bunsen photometer that 16 candle-power 100 volts Edison-Swan lamps give on an average 15 candle-power at 98 volts, and 17 candle-power at 100 volts; but there are variations to the extent of 1 candle-power in many cases.—Yours, &c.,

David Salomons.

Broomhill, Tunbridge Wells, March 6, 1890.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The remarks which you make in your "Notes" upon my letter in last week's *Electrician*, on the "Life and Efficiency of Glow Lamps," were matters of which I was cognisant when inditing my letter; but your remarks do not at all lessen the value of my recommendation for referring the life of glow lamps to some standard of efficiency (say, 3½ watts per candle-power, or a fixed temperature). This is chiefly because of the fact that if any lamps were running at their most "economical efficiency," *i.e.*, that efficiency required to minimise the working expenses which you refer to, and if they had either to be referred back or forward to a fixed standard of efficiency, then, their life, at any other efficiency best for economy, would be proportional (other things being equal) to their life at the recognised standard of efficiency.

I agree with you that it would be unfair to compare all lamps under the condition of constant efficiency—but only in the monetary sense, for such a comparison would still be fair as regards life. I think that I was one of the very first to notice and point out the fact of there being a best efficiency at which to run lamps, according to local and other variations in the price of electrical power and lamp renewals. I personally made the necessary experiments, and gave my results to Prof. Ayrton, and the same formed the basis of a Paper entitled "The most Economical Potential Difference to employ with Incandescent Lamps," which was read by Profs. Ayrton and Perry at the Physical Society, February 28, 1885, and published in *The Electrician* of the same or the following week.—Yours, &c., C. J. Robertson, A.I.E.E.

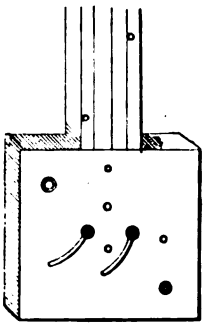
Middelburg, Holland, March 3, 1890.

[Our correspondent's reasoning about the life of lamps is not very clear, but his suggestion is valuable, the only difficulty being in getting the necessary data.—Ed. *E.*]

RIVAL BACK BLOCKS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your issue of February 21st you gave us an illustration of an improved back block. Though doubtless very nice-looking, I must respectfully say I cannot possibly perceive any improvement on the back block of which I send an illustration. This consists of only one block, which is made of hard wood, and can be either turned or left square. A groove is then cut in the block exactly the width and thickness of the casing, and is taken half an inch lower than the centre of block, the blocks in every case being the thickness of the casing and cover, so that when the casing is placed tightly in the groove the cover fits down square on the top part of the block and flush with the front, as shown in the figure. The



casing is fixed to the block by three small screws. Two holes, through which the wires pass, are bored the same distance apart as the grooves in the casing. The advantages of this block are that it can be fixed a little below the plaster—the block being perfectly damp-proof, the wires take no hurt; it can be easily and quickly made, and quickly fixed, and in instances where the casing is on the face of a wall, the block may be turned and polished, which gives it a finished and compact appearance.—Yours, &c., J. J. Hine.

Thorpe, Chertsey, February 22, 1890.

THE CITY OF LONDON AND SOUTHWARK SUBWAY RAILWAY.

On Wednesday, on the invitation of the Chairman and Directors of the City of London and Southwark Subway Company, the Lord Mayor and a large number of gentlemen connected with railway and commercial undertakings made a trial trip over this railway. For the purposes of the trial trip an engine and a couple of carriages were brought into requisition. The run down to the "Elephant and Castle," which is about a mile and a-third in point of distance, was accomplished in a little over four minutes. Arrived at the Elephant Station, Mr. Greathead, the engineer, gave some interesting particulars concerning the way in which the work had been carried out.

The chief features of interest having been explained to the Lord Mayor and the party, the visitors took their seats for the return journey; but the train would not start. It was explained that the mishap had nothing whatever to do with either permanent way, locomotive, or the electric generating appliances, but was owing simply to the fact that the turncock of the Southwark and Vauxhall Water Company refused to "turn on" the water required at the generating station. After being kept at the station for something like an hour over the time laid down in the programme, the train ran swiftly back to King William-street.

The party then partook of luncheon, laid out in a large room forming a portion of the offices of the Company at King William-street. The chair was taken by Mr. G. C. Mott, the Chairman of the Board of Directors of the Company, and he expressed his regret at the misadventure that had occurred which had necessitated the absence of some of their distinguished guests.

Lord COBHAM said that, although there was no regular list of toasts, he was desirous of proposing "Success to the City of London and Southwark Subway Company." He said the undertaking that the Directors of the Company had under their control was one of the most novel description. He believed that such a system would meet a great necessity, and he called upon them to acknowledge the efforts of Mr. Mott and the other Directors of the Company who had been foremost in the movement.

The CHAIRMAN, in acknowledging the compliment on behalf of himself and his fellow-Directors, regretted the delay that had occurred in consequence of the action of the Southwark and Vauxhall Water Company in cutting off the supply of water to the engine. After giving some interesting statistics with regard to the growth of street traffic in the metropolis, Mr. Mott expressed the thanks of the directors to Dr. Edward Hopkinson and Dr. John Hopkinson, the electricians, for the admirable way in which they had worked,

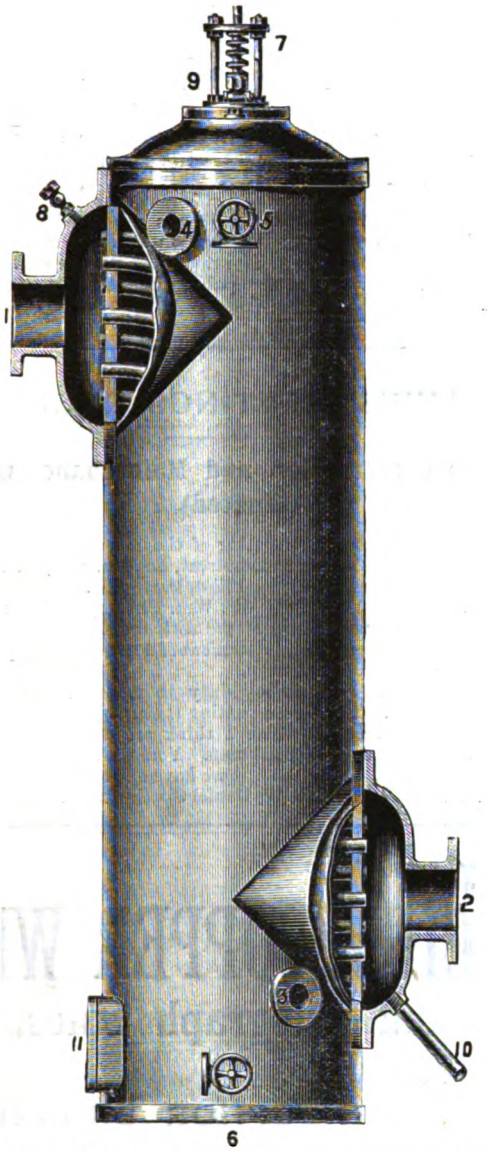
Mr. MATHER, M.P., in acknowledgment of what the Chairman had said, remarked that the Directors had shown their confidence in the undertaking by calling them together before the absolute completion of the work. He trusted that by means of these railways the congestion of traffic in London would be overcome, and that the public would in future be able to travel with much greater comfort than they could now.

The proceedings then terminated.

Digitized by Google

THE "COMPACTUM" FEED-WATER HEATER.

The apparatus described below (which is specially designed for high-speed and other electric light engines) consists of a cast-iron casing fitted with a number of solid-drawn brass S tubes, through which the exhaust steam passes. The ends of these S tubes are securely fixed in tube plates formed in the case, which, while keeping the ends tight, allows the body of the tube to expand; these tube ends can be easily got at by removing covers and one length of exhaust pipe, without disturbing the heater. The feed-water is pumped through the heater, entering at the bottom and passing out at the top to the boilers, being heated on its passage through, and depositing its scale and grease in the heater; the former falling down clear of the tubes, can be blown or scraped out from time to time. An arrangement is provided for the extraction of air and grease. There is also a connection on the exhaust outlet cover to take away the condensed steam, thus relieving the back pressure and giving a supply of hot fresh water, which can either be used over again as feed-water or for a variety of other purposes. The top cover and bottom sludge doors are easily removed, thus allowing for tubes to be readily got at for cleaning



1, Exhaust inlet; 2, exhaust outlet; 3, feed inlet from pump; 4, feed outlet to boilers; 5, scum valve; 6, drain and sludge valve; 7, relief valve; 8, soda cock; 9, soda and air cock; 10, drain from tubes; 11, cleaning door.

purposes. The apparatus is of moderate weight and dimensions, and no special foundations or brickwork are required, while the cost of fitting is smaller than for other heaters.

The use of this apparatus ensures economy in working, as with a little attention it will, in addition to heating the feed-water, remove nearly all the solids, grease, and air, thus saving the costly cleaning and dangerous deposits so common in feed-waters. The "Compactum" is specially designed for applying to the exhaust of high-speed engines for driving dynamos, &c., and it is claimed by the manufacturers, John Kirkaldy (Limited), of 40, West India Dock-road, London, E., that the large amount of heat which is imparted to the feed-water on its passage through the heater causes a saving of at least 15 per cent. on the expenditure in the boiler department. Our readers will readily appreciate this great economy in working.

Messrs. Kirkaldy make a speciality of feed-water heaters and condensers for all purposes, and it may be said for the "Heater" under notice that it has been designed and constructed upon scientific lines.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning.*]

RESULT OF TENDER.—At the meeting of the London Council on Tuesday, the Council Chamber and Offices Committee stated that they were of opinion that it would be desirable to adopt the electric light for the new Council Chamber at Spring-gardens. They had been in communication with several electric lighting firms, and had obtained estimates of the cost of installation. The estimate they thought the most favourable, having regard to the amount of light to be afforded and other details, was that of Messrs. Strode and Co., the amount of the estimate being £208. They recommended "That the electric light be adopted for the Council Chamber at Spring-gardens, and that the work be entrusted to Messrs. Strode and Co. to carry out upon the basis of their estimate." This recommendation was adopted.

ELECTRIC LAUNCHES.—We learn that Messrs. T. B. Seath and Co., Rutherglen, have secured an order for four electric launches from Messrs. Morton and Williamson, Glasgow, acting, it is understood, on behalf of the Electric Traction Company in London, who will themselves supply the electrical apparatus for propelling the launches. They are intended for service on the Seine.

SALES BY AUCTION.—Messrs. Wheatley Kirk, Price, and Goulty will sell by auction during the present month a quantity of modern engineering machine plant, tools, and stores. The sale will take place at the Works, 417, Old Ford-road, London, E. Particulars will be found on page 3 of Advertisements.

——— Messrs. Smith and Ford announce the sale on Monday, March 10th, at Battersea, of boiler, vacuum pump, foundry crane, steel shafting, chemicals, and the contents of a chemical laboratory, including gas apparatus, furnaces, &c.

THE UNITED ASBESTOS COMPANY.—This Company have removed their chief offices from 161, Queen Victoria-street, to the Dock House, Billiter-street, London, E.C. We have received from the Company two neatly printed pamphlets, the smaller of which contains illustrations of their mills and offices and particulars of their various manufactures. The larger pamphlet gives a quantity of information respecting the asbestos, &c., goods manufactured by the United. A portion of page 27 is devoted to the electrical department, from which it will be seen that a number of articles in everyday use by electrical engineers are manufactured by the Company, which claims to be the only asbestos company in the world owning and working asbestos mines both in Canada and in Italy.

DISSOLUTION OF PARTNERSHIP.—Messrs. Price and Belsham, of 52, Queen Victoria-street, London, E.C., have dissolved partnership.

"THE ELECTRICIAN"

ELECTRICAL TRADES' DIRECTORY & HANDBOOK for 1890

The new edition of our well-known Directory and Handbook is now ready. The book consists of 850 pages, and has entailed this year an exceptionally heavy amount of work. The HANDBOOK DIVISION contains a mass of most useful information. The DIRECTORY DIVISION consists of more than 400 pages, and contains a very carefully compiled Alphabetical and Classified List of Firms and Persons engaged in the Electrical and Allied Trades in all parts of the world. This Division has been corrected up to date, and the book is thoroughly reliable, even the very numerous changes which take place in the month of January being incorporated. The book is not a mere list of Members of Scientific Societies repeated again and again. The Colonial and Foreign Division will be found extensive and reliable. The book has been very favourably reviewed by the Press. *Orders should be forwarded at once.*

WESTMINSTER ELECTRIC SUPPLY CORPORATION (LIMITED).—An extraordinary general meeting of this Corporation was held on Wednesday at the Company's offices, 4, Victoria Mansions, London, S.W., under the presidency of Lord Suffield, when alterations in several of the Articles of Association were agreed upon,

Digitized by Google

LEGAL INTELLIGENCE.

Aron Bros. v. Watson Bros.

In this case, heard in the City of London Court on February 26th, before Mr. Registrar Wild, the plaintiffs, Messrs. Aron Brothers, Bridewell-place, sought to recover the sum of £7, the price of a portable electric lamp supplied to the defendants, Messrs. Watson Brothers, opticians, electrical engineers, &c., of 4, Pall-mall. Mr. Shape, the plaintiffs' traveller, said that in December he called on the defendants, and saw one of them about the sale of one of the plaintiffs' lamps to them. He left a prospectus, and afterwards showed them a lamp. Some little discussion ensued between the two brothers, when one of them gave an order for a lamp.

Mr. REED (for the plaintiffs) said he understood it would be a question whether the lamp burned a certain number of hours.

Mr. KEBBELL (for the defendants): The question is whether it will burn at all. The witness said he examined the lamp, and found it in perfect condition.

Mr. KEBBELL: My defence is that the lamp would not act.

Mr. REED: The simplest plan is to light it.

The REGISTRAR: Are we to sit here for five hours to see if it will burn?

Mr. KEBBELL: The prospectus says five hours to eight.

Mr. REED said they were prepared to prove the lamp would burn from five to eight hours.

Mr. KEBBELL said the intensity of light was to be 25 candles. The lamp was returned as it had never burned for two hours, and the light was very bad during that time.

Mr. SHAPE said he offered to give the defendants every possible assistance to show them that the lamp would run the time he alleged. They would not, however, allow him to do anything to it at all. The lamp was returned by the defendants in a defective condition. One of the poles had been knocked off. It was not possible for the lamp to burn without it. In cross-examination, he said he offered to test the lamp. He was not now in the plaintiffs' employment. He did not claim commission on this order. He told the defendants the lamp was the best thing in the world, which was true.

Mr. ARON, one of the plaintiffs, said he guaranteed the lamps. He had been burning them since October. They always burned from five to eight hours, and he had seen some burn ten hours, but they were never less than five. He had never had any complaints before.

Mr. KEBBELL said his case was that the plaintiffs' traveller was anxious for the defendants to buy a lamp, and he recommended it as the best thing out. The defendants, instead of that, found it would not go, and sent it back.

Mr. A. H. WATSON said he was an electrical engineer, and therefore acquainted with these lamps. He had a lot to do with the many different kinds of lamps, but he had not seen this one until the traveller called his attention to it. The traveller said it would burn for five hours. He was particular in asking that question, as many of these lamps would not do that which was stated of them. When the lamp came he carried out the instructions contained in the prospectus. The light they obtained was certainly not 25 candle-power, as represented. An hour after the light had been burning it perceptibly diminished, whereas at an hour and a-half it was practically no use as a light. There was a red glow in the light, but it did not illuminate. He did not refuse to let the plaintiffs' traveller test the light. On the contrary, he said he would accept any suggestions, as he had wasted several hours on the lamp. The lamp was not damaged when he sent it back.

The REGISTRAR said he must find for the defendants with costs. If the defendants, who knew something about electric lamps, could not make it work, how could the public be expected to do so?

Christopher v. Langworth and Others.

This was an appeal, heard before the Lord Chief Justice and the Master of the Rolls, sitting as a Divisional Court, on Thursday, 27th ult., by the plaintiff from a decision of the Court below, striking out, as vexatious and frivolous, the claims of the surviving executors of the late Mr. Thomas Allen, electrician, against the International Telegraph Company to recover the sum of about £1,000,000 sterling. Mr. Thomas Allen was connected with the laying of the submarine cable between England and Holland, and he obtained a concession from the Dutch Government by which he acquired certain rights and privileges. The cable ultimately came into the hands of the International Telegraph Company, and the plaintiffs now alleged that the directors had, by falsifying the accounts, deprived them, as the surviving executors of Mr. Allen, of their proper share of the profits to the extent of about £1,000,000. Their Lordships, after reading the statement of claim, said it was quite evident that the learned judge was right in characterising the action as vexatious and frivolous. There was no proof of fraud whatever, and the appeal would be dismissed with costs.

In re James Fyfe.

On Thursday last week, at the London Bankruptcy Court, a meeting was held before Mr. Registrar Brougham, for the public examination of James Fyfe, described as of St. Stephen's-chambers, Telegraph-street.

The debtor was the managing director of the Pilsen-Joel and General Electric Light Company, and was also part promoter of the Ross Oil Lighting Company, as well as promoter in England for a scheme for lighting by electricity the town of Las Palmas, Canary Islands. The statement of affairs shows liabilities £18,707, of which £1,298 is unsecured, and no available assets.

In the course of examination by Mr. Aldridge, the debtor stated that he had been an electrical engineer for the last 10 years, and the latter part of that time he had acted as managing director to the Pilsen-Joel Company. He had a claim against the Company (which was now in liquidation) for £3,000, but the claim was disputed. He was associated with Mr. Howes and had paid him a certain sum for patents which were now being worked by a Company, and he had a salary for managing the patents.

In the absence of opposition, the public examination was ordered to be concluded.

COMPANIES' MEETINGS & REPORTS.

Telegraph Construction and Maintenance Company (Limited).

The 26th ordinary general meeting of the members of this Company was held at the offices, 38, Old Broad-street, London, E.C., on the 4th inst., under the presidency of Sir George Elliot, Bart., M.P.

The MANAGING DIRECTOR (Mr. Wm. Shuter) read the notice calling the meeting, and the minutes of the 25th ordinary general meeting.

The report of the Directors and statement of accounts (the report appeared in our last issue) were taken as read.

The CHAIRMAN: It is now my duty to move that the report and accounts be adopted. But before putting that resolution I will proceed to address to you a few remarks which I think are due from me on my first appearing before you as your Chairman. You will, doubtless, expect me in the first place to allude to the loss we have all sustained in the death of our former Chairman—the late Sir Daniel Gooch—under whose administra-

PATENT
SILICIUM BRONZE AND SILICIUM COPPER WIRE.
The best for overhead Telephone and Telegraph Lines,
AND ALL ELECTRICAL PURPOSES.
Hard Drawn High Conductivity Copper Wire.
ROLLED AND DRAWN
PHOSPHOR BRONZE.
PHOSPHOR BRONZE
VULCAN PHOSPHOR DURO METAL
PHOSPHOR BRONZE
BEARINGS, BUSHES,
AND OTHER PARTS OF
ELECTRICAL MACHINERY.
SOLE PROPRIETORS of the British, Indian and Colonial Patents,
THE PHOSPHOR BRONZE COMPANY (Limited),
87, Sumner Street, Southwark, London, S.E.
WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

Digitized by Google

tion the Company has enjoyed an unbroken period of prosperity for so many years. I and my colleagues feel that your sympathy and theirs are in common in this lamentable event, and that the resolution passed by us, and which appears in the report, will have met with your entire approval. I next desire to explain briefly the reasons which have induced me to comply with the unanimous request of my colleagues that I should accept the office of Chairman. There are, I dare say, some among you who are aware that I have been a Director of the Company since its formation 26 years since, and that ten years previously to that time I was an original active partner in the business before it became the property of the Company. It would, therefore, be affectation on my part to say that I have not as fair a knowledge of all its working as any individual can have, and I have only to add that I take as keen an interest in its prosperity as I did when it was partly my own property—chiefly, I might almost say. You may therefore rely that no effort will be wanting on my part to ensure its continued success. That success has in my opinion been due hitherto in no small measure to the policy adopted by the Board from the first; that is, while giving the shareholders every information which they could reasonably desire, the Board yet maintained due reticence in regard to business matters, the publication of which might injuriously affect the Company's interests. The shareholders hitherto have accepted this policy, and have placed that confidence in their Directors without which they could not have achieved this success. I trust that in the interests of us all this course may still in a great measure be followed. Of course, there are other causes to which the prosperity of the Company is due, and I should be wanting in fairness to the executive and the staff of the Company if I did not say that it is largely—I would say very largely—attributable to the energy, ability, and industry exhibited by them. My predecessor had perfect confidence in the arrangements and the executive officers of the Company, and I can truly say that I share that feeling I am very glad to say that some of those officers were officers under me when the Company was a private firm. As regards the work carried out during the year, you will judge from the report that we have not much to complain of. Our profits have been largely due to the improvement of our general business other than mere submarine telegraphy. I think that is very agreeable intelligence, because we have something else besides the submarine telegraph upon which we can rely, and which we are trying to extend. As far as we are able to judge at this early period of the year, our prospects appear favourable. We have two contracts in hand—one to lay a cable—it is a large work—between Australia and New Zealand, and that cable is now despatched. The other contract is to renew a portion of the Madras-Penang cable, which next week will have to be carried out. Work is always arriving for us, and I have strong faith that it will continue. Periodically there appears to be no great future for it, but demands always seem to arise and seem to be able to keep us fully employed, or nearly so. We have an excellent staff of agents. We have Mr. Shuter, our Managing Director, and Sir George Richards, and we have an excellent staff who are the strength of our business. I think as far as the cable portion of our business is concerned we stand far, far away unrivalled by any other company. I now propose:—

"*That the report and accounts of the Directors to December 31, 1889, submitted to this meeting be and the same are hereby received and adopted, and that a dividend of 36s. per share, in addition to 12s. interest or interim dividend paid on July 16, 1889, be paid on all the shares of the Company for the year ended December 31, 1889, and such dividend to be paid free of income-tax.*"

Mr. GEORGE W. CAMPBELL: I have much pleasure in seconding that.

The CHAIRMAN put the motion, which was carried unanimously. Continuing, he said: There is another resolution, which relates to our retiring Directors—Sir Thomas Fairbairn, who is not present, and our young friend here, Mr. James Pender, who, I trust, will be a very great help and support to the Board. I move:—

"*That Sir Thomas Fairbairn, Bart., and Mr. James Pender be re-elected Directors of the Company.*"

Admiral Sir GEORGE H. RICHARDS, K.C.B., F.R.S., seconded the motion, which was carried unanimously.

On the motion of Mr. CROFT, seconded by Mr. HEWAT, Mr. John Gane, F.C.A., was re-elected an auditor of the Company for the year 1890, and subsequently, on the motion of Mr. CROFT, seconded by Mr. MACKAY, Mr. Patrick Glegg, of the firm of Messrs. Weldon, Jones, and Co., was elected an auditor in the place of Mr. James Glegg, resigned.

The CHAIRMAN announced the close of the business, and thanked the shareholders for their attendance.

Mr. DOYLE proposed a cordial vote of thanks to the Chairman and Directors.

Mr. HEWAT seconded the motion, which was carried *nem. con.*

The CHAIRMAN: I thank you very sincerely for the cordial and polite manner in which you have proposed this resolution. I hope, although it is some time since we began this business, that we shall still have several opportunities of meeting each other, and congratulating ourselves on a good business and an unvarying dividend.

The proceedings then terminated.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended February 28th amounted to £5,025.

BRUSH ELECTRICAL ENGINEERING COMPANY (LIMITED).—The following circular has been issued to the shareholders of this Company:—"Six months having elapsed on the 10th February since the registration of the Brush Electrical Engineering Company (Limited), the Directors have pleasure in stating that practically the reconstruction has been completed, and that the business of the Company is established on a satisfactory and permanent basis. The total amount of orders received by the Company is very satisfactory, and the prospects for the future are highly encouraging. The works of the Company in London, at Loughborough, and on the Continent are fully occupied, and the extensions of the Falcon Works at Loughborough are making rapid progress towards completion. The Directors have decided, in view of the satisfactory volume of business transacted during the past six months, to pay a dividend on the Preference shares; and warrants for an interim dividend on these shares at the rate of 6 per cent. per annum, from August 10, 1889 (the date of registration of the Company), to February 10, 1890, are issued with this circular. The books of the Company will not be made up until the close of the year, and the Directors reserve the question of a dividend on the ordinary shares until the complete accounts are before them."

CUBA SUBMARINE TELEGRAPH COMPANY.—The estimated traffic receipts of this Company for the month of February were £3,300, as compared with £3,204 in the corresponding month of last year. The receipts for the month of November, estimated at £3,000, realised £3,112.

DIRECT SPANISH TELEGRAPH COMPANY.—The traffic receipts of this Company for the month of February show an increase of £217 as compared with the corresponding period.

EASTERN TELEGRAPH COMPANY.—The traffic receipts of this Company for the month of February amounted to £53,347, as against £54,611 in the corresponding period of 1889, a decrease of £1,264.

EASTERN EXTENSION TELEGRAPH COMPANY.—The traffic receipts of this Company for the month of February were £38,466, as against £37,584 for the same period of 1889.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic returns of this Company for the month of February amounted to £19,800. From the 1st January to 28th February these receipts amounted to £39,400, against, in the corresponding months of 1888 and 1889, £41,800 and £42,000 respectively.

WEST COAST OF AMERICA TELEGRAPH COMPANY.—The traffic receipts of this Company for the month ended February 28th amounted to £4,500.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The receipts of this Company for the half-month ended February 28th show an increase of £335 as compared with the corresponding period.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended February 28th, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,858.

THE NON-CONDUCTOR OF ELECTRICITY.

VULCANISED FIBRE,

PATENTED.

This new material is supplied in two qualities, Flexible and Hard.

The FLEXIBLE is a substitute for Leather, Rubber, Gutta Percha, &c., and is extensively used by Brass Founders, Axle Makers, Hydraulic, Sanitary, and other Engineers, Pump Makers, Carriage Builders, &c.

It makes the best Hot and Cold Water Packings, and for Axle Washers of all kinds it is unequalled.

The HARD is a substitute for Metals, Hard Wood, Ivory, Vulcanite, Ebonite, &c., and is a good Insulator.

Sold in sheets, 5ft. 6in. by 3ft. 6in., varying in thickness from 1-50in. to 1in.

FLEXIBLE, 2/- per lb.; HARD, 2/3 per lb.

FACTORY.

MOSSES & MITCHELL, 70 Chiswell-st., London, E.C.

Digitized by Google

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Wednesday, March 5, 1890.	Rate per Cent. Yielded.	Dividend Due.	Business Done during Week Ending March 5, 1890.	
£			**TELEGRAPHS.**		£ s. d.		Highest.	Lowest.
1,770,360	Stock	12/6	Anglo-American	49 50	5 10 0	Jan., Apr., July, Oct.	50	...
2,614,820	Stock	25/0	Do. Preferred	82½ 83½	6 11 9	" "	84¼	82½
2,614,820	Stock	...	Do. Deferred	14½ 14⅝	...	February	14⅝	14⅜
130,000	£10	3/0	Brazilian Submarine	12⅛ 13	5 15 5	Mar., June, Oct., Dec.	12⅞	12⅛
112,900	£100	5%	Do. 5 per Cent. Bonds	100 102	4 18 0	January and July	...	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	104 107	4 13 6	June and December.	...	...
16,000	10	9/0	Cuba Submarine	11½ 11⅝	7 13 3	February and August	...	...
6,000	10	10%	Do. Preference 10%	18 19	5 5 3	" "	18	...
12,931	5	2/0	Direct Spanish (£4 paid)	¼ ½	4 8 11	March & September	...	...
6,000	5	10%	Do. Preference 10%	9 10	5 0 0	April and October	...	...
60,710	20	3/6	Direct United States	10 10½	6 19 4	Jan., Apr., July, Oct.	10½	10
880,000	10	2/6	Eastern	13¾ 14⅛	4 12 0	" "	14⅛	13⅞
70,000	10	6%	Do. 6 per Cent. Preference	14⅛ 15½	3 18 8	" "	15⅛	15
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock	105 107	3 14 9	May and November.	107	106½
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	106 109	4 11 9	February & August	...	...
250,000	10	2/6	Eastern Extension	13⅜ 14	4 12 10	Jan., Apr., July, Oct.	14	13⅛
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	100 102	5 17 8	February & August	...	...
473,000	100	5%	Do. 5 per Ct. (Austrln. Gov. Sub.) Debs. 1900	102 105	4 15 3	January and July	...	...
179,177	10	1/9	Globe Telegraph and Trust	8⅛ 8⅞	5 15 6	Jan., Apr., July, Oct.	8⅞	8⅛
178,992	10	6%	Do. 6 per Cent. Preference	14½ 14⅝	4 1 4	" "	14⅝	14⅞
150,000	10	5/0	Great Northern	15¼ 15⅞	4 15 3	Jan., July, and April	15⅝	15⅜
17,000	25	12/6	Indo-European	41 43	5 16 3	April and October	...	...
9,000	8	4/0	Reuter's	7 7½	5 6 5	April and October	7 1/16	...
15,609	10	3/6	West African Telegraph	9½ 10⅛	...	...	...	...
800,000	100	5%	Do. 5 per Cent. Debentures	97 100	5 0 0	March & September	...	...
30,000	10	5/0	West Coast of America	10½ 11	4 10 11	January and July	...	...
150,000	100	8%	Do. Debentures 8%	119 124	6 9 1	June and December	123	...
88,321	10	nil.	West India and Panama	3⅛ 3⅜	...	...	3⅜	3⅛
34,563	10	12/0	Do. 1st Preference 6%	11⅜ 12¼	...	April and October	12	...
4,669	10	10/0	Do. 6 per Cent. 2nd Preference	15 16	3 15 0	...	...	...
45,181	15	6/0	Western Brazilian	10½ 11	...	May & November	10⅛	10½
$1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	118 122	5 14 9	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	99 101	5 18 10	March & September	...	...
			TELEPHONES.					
224,850	14/0	5%	Consolidated Telephone and Maintenance	1/16 1/8	...	Yearly	1/16	...
220,000	£1	3%	Oriental (11s. paid)	7/16 ½	3 5 11	...	...	...
80,000	5	6%	National	5 5¼	...	June and December.	5¼	5
55,000	5	3/0	United River Plate	4⅜ 5⅛	...	January and July	...	...
			ELECTRIC LIGHT.					
500,000	10	...	Metropolitan Electric Supply (£5 paid)	5⅜ 6⅛	...	...	6	5⅞
79,234	5	6%	Swan United (£3. 10s. paid)	5¼ 5⅜	3 13 0	...	5⅜	5⅛
			MISCELLANEOUS.					
37,350	12	12/0	Telegraph Construction and Maintenance	44 46	5 2 7	March and July	46¼	45
41,600	10	10/0	India Rubber, Gutta Percha & Telegraph Works	17½ 18½	5 8 1	February & August	18½	18

JABLOCHKOFF'S

DISTRIBUTION PATENT

(Being a Patent for "Producing and Dividing Electric Light," No. 1996 of 1877.)

THE

ELECTRICAL ENGINEERING CORPORATION, Ltd.

(STATTER'S) **Are Proprietors of the above Patent, and Warn the Public against Infringement.** (UNITED)

The following are Licensees:—

Brush Electrical Engineering Company, Limited.
Crompton & Co., Limited.
S. Z. de Ferranti.—London Electric Supply Corporation, Limited.
W. T. Goolden & Co.
Hammond & Co.
Wilson Hartnell.
Johnson & Phillips.
Laurence, Paris & Scott, Limited.
Nalder Brothers & Co.
Paterson & Cooper.
Ernest Scott & Co.
Siemens Brothers & Co., Limited.

3, Prince's Mansions, Victoria Street, Westminster. PERCY E. SCRUTTON, *Secretary.*

Digitized by Google

THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 617.—Vol. XXIV. FRIDAY, MARCH 14, 1890. Price Fourpence.

NOTES.

Encouraged doubtless by their legal victories in connection with Edison's incandescent lamp patent, No. 4,576 of 1879, and the "flashing" patent, No. 4,847 of 1878, the Edison-Swan Company are, we hear, taking steps to enforce their rights under Edison's "feeder" patent, No. 3,880 of 1880. Although it may be said of this, as indeed of almost every other patent in existence, that anyone setting himself to solve the particular problem in question would probably have arrived at the same result; it must be admitted that Edison had at a very early date grasped the difficulties of the case and the best way of overcoming them.

The specification commences with the statement that "where many translating devices for converting electricity into either power or light are arranged upon the multiple arc or derived circuit system, it is essential that, so far as possible, an equal electromotive force or 'pressure' be maintained in all parts of the system. When, however, each set of conductors is run out from the central station in a straight circuit containing a number of translating devices, the pressure when a number of devices are in operation is apt to be greatest nearest the central station, and to diminish gradually toward the end of the conductors, this 'drop' being due to the resistance of the main conductors. The object of this invention is to obviate such irregularity, and to maintain practically throughout the entire system an equal pressure. This is accomplished by using the conductors leading directly from the source of energy as feeding conductors only, placing no lamps ordinarily in the circuit connected directly to the source, placing the lamps or translating devices upon service or lamp circuits, which connect to and are fed by the feeding conductors in such manner that all the lamp circuits are electrically distant substantially from the source of electricity by the same mass of conductor. By so doing the greater portion, if not all, the drop occurs in the feeding conductors, the pressure in the service or lamp circuits being practically uniform at all points." Several variations of the feeder system are then fully and clearly described.

Twelve claims are made, although the whole essence of the "discovery" may be found in those quoted below:—I. The method of equalising the pressure or electromotive force throughout an electric distributive and translation system, consisting in using feeding circuits which connect to and feed into circuits on which are arranged the translating devices substantially as set forth. II. The combination with a circuit containing translating devices of a feeding circuit leading thereto from the source of energy and containing no translating devices, substantially as set forth. IX. The method of laying the conductors in an electrical supply system, consisting in laying them in sets concentrically as explained, each set being connected to the central station at several points, substantially as set forth.

Sir James Anderson's reply to Mr. Henniker Heaton, in the *Pall Mall Gazette* of Monday last, is one of those practical statements of fact which Mr. Heaton is not accustomed to in the House of Commons, and rarely in the public press. The two principal propositions of which Mr. Heaton is the leading expounder and advocate may be briefly described as the purchase of the submarine cables and reduction of the rates by the British Government; or, failing this, the reduction by the existing companies of the tariff to the Far East to one shilling a word—a tariff which he alleges would yield them a profit. As regards the latter, Sir James shows that the out payments alone to the several telegraph administrations between here and Australia—exclusive of the Eastern Extension Company's proportion—absorb no less a sum than 4s. 10d. per word. In order, therefore, to reduce the total tariff to one shilling per word, and leave a proportion for the Cable Companies, the other administrations, many of them those of foreign Governments, would have to forego nine-tenths of their present charges, which they are hardly likely to do. With regard to the idea of purchase, Sir James argues the matter at some length, conclusively showing that, if for no other reason, the objection of foreign Governments to the necessary conversion of a commercial company's offices on their territory into British Government stations is fatal to any such proposition.

The measurements of the specific inductive capacity of various dielectrics, made by Messrs. Safford and Holman, and reproduced in another column, will be of practical importance for telephonic purposes, since they have been made under conditions similar to those usual in telephonic work. No one would think of testing the insulation resistance of a cable intended to work at a pressure of a thousand volts with the ordinary potentials used with a Wheatstone bridge. Although the

Digitized by Google

cable might sustain the pressure, the resistance would be quite different under the two sets of conditions. For a similar reason it is not surprising that the authors have found that the numbers obtained by testing telephonic cables by the ordinary galvanometer methods are quite useless for telephonic work. The inductive capacity is found to vary considerably with the frequency of the current changes. Although the values obtained will be of considerable use for the purposes for which the tests were made, it may, however, be disputed whether the numbers given truly represent the specific inductive capacity of the dielectrics. The phenomena connected with rapid variations of potential in dielectrics are very complicated.

THE dynamo just brought out by MM. REIGNIER and BARY, to which our Paris correspondent alludes, is certainly a remarkable machine from the point of view of output for weight. A ten and a-half kilowatt machine weighs only 578lb., and it therefore gives over 18 watts for every pound of dead weight.

DR. JAMES MOSER'S short Paper, which we print in another column, furnishes an extremely pretty demonstration of what has, we believe, never before been so effectively demonstrated, viz., the probability that a perfect vacuum is a non-conductor, and not, as was quite recently held by some, a perfect conductor. The experiment is such a simple one that we may expect to see it often made use of for lecture purposes.

IN the March number of the *Phil. Mag.* Prof. PERRY discusses the behaviour of twisted strips. These strips must not be confused with the well-known AYRTON and PERRY magnifying springs. They are formed by giving a permanent spiral twist to a straight strip of metal by applying a twisting moment about its axis. When such a strip is pulled in the direction of its axis a small extension takes place, accompanied by a comparatively large rotation of the free end of the strip. The method of multiplication may be turned to practical advantage in many directions. The strips may be made of various sizes, suitable either for weighing-machines where large forces have to be measured, or for delicate instruments, such as thermometers and galvanometers, where excessively small motions have to be rendered visible. At the Newcastle meeting of the British Association, Prof. PERRY showed several voltmeters in which very delicate twisted strips were employed. They seem as well, if not better, fitted for use in measuring-instruments than AYRTON and PERRY springs; but their behaviour is so curious that all attempts at forming a working theory of their action have hitherto failed. The phenomena are exceedingly complicated, and Prof. PERRY'S theory is confessedly incomplete.

IN the same magazine H. DU BOIS describes a valuable research on KERR'S phenomenon, undertaken with the special object of showing the intimate connection between the rotation of the polarised light and the intensity of magnetisation of the body at the polished surface of which the light is reflected. Ellipsoidal-shaped specimens of different metals were taken, the end of each being cut off and the surface polished so as to form a mirror. To avoid optical complication the light was always reflected normally to the surface. The amount of the rotation produced by reflection was found to be proportional to the intensity of magnetisation when the mirror was cut perpendicularly to the lines of force. When the axis of the mirror was inclined to the lines of force the rotation was proportional to the cosine of the angle of inclination. The verification of this law for five different angles is important, as it has not been done before. Experiments were also made to determine the influence of temperature, with the result that for a range of over 200° C. the ratio between rotation and the magnetic intensity was unaltered for either cobalt, iron, or steel. Some slight differences in the case of nickel are easily explained by the fact that the intensity of magnetisation just behind the mirror differed from the measured mean intensity of the magnetised body. That the effect depended purely on magnetisation, and not on the method by which it was produced, was shown by obtaining the same results when residual magnetism alone was used. The variation of rotation with colour was also investigated. The intimate connection between KERR'S phenomenon and FARADAY'S magnetic rotation is clearly shown by these experiments. The rotation produced is dependent on the intensity of magnetisation immediately behind the mirror, and is probably due to the rays of light penetrating a slight distance into the material before the act of reflection is completed.

OWING to the fact that Mr. H. D. WILKINSON has been for some little time past suffering from illness, he has been unable to recommence his interesting series of articles "Letters for Learners and Unprofessional Readers." Mr. WILKINSON starts on Saturday for the Cape of Good Hope to recruit his health; and he hopes to resume the series on his return to England in the summer.

WE have to acknowledge with our warmest thanks the many letters of sympathy we have received in respect to the late Editor of this journal, all of them couched in terms of admiration and regard which a character such as his naturally calls forth. As Prof. CROOKES truly said in moving a vote of condolence last night at the Institution of Electrical Engineers, "he was popular with all who knew him."

Hamburg.—According to the *Elektrotechnische Echo* the Town Council is considering a scheme of electric lighting on the Popp system.

St. Moritzbad.—The large hotels of this town intend to use the water power of the Silvaplana, three miles distant, for supplying a central station.

Oxford.—At its last meeting the Oxford City Council unanimously passed a resolution assenting to the proposed order of the Electric Installation and Maintenance Company.

Testing Galvanometers.—We have received, too late for insertion in this week's issue, a long communication from Messrs. Elliott Bros. in reply to Prof. Ayrton's letter of last week.

The Bakerian Lecture.—The subject of the Bakerian Lecture, which is to be delivered by Prof. Schuster on March 20th, will be "The Discharge of Electricity through Gases."

Digitized by Google

Bolton.—The Corporation has sent out circulars inquiring from the large consumers of gas whether they are desirous of having the electric light. The price will be 10d. per Board of Trade unit.

The Telephone in Germany.—The traffic on the telephone line between Berlin and Breslau is so great that the postal authorities are considering the advisability of erecting an additional wire between these two cities.

Personal.—Mr. Kenneth MacIver, of the National Telephone Company, has been appointed to a position in the London office of the Company; Mr. Chambers, from Leeds, succeeding Mr. MacIver as manager of the Manchester district.

Blankenburg-a-Harz.—The authorities have signed a contract for the lighting of the streets and the public buildings with the Fabrik für Elektrotechnik of Bamberg. The price to be paid for a 16 candle-power lamp is one farthing per hour.

Electric Traction Experiment.—The Directors of the Vale of Clyde Tramway Company have agreed to allow an experiment to be made on their Govan section with some electrical cars, and in a few days it is expected that a car will be running between Glasgow and Govan.

Florence.—The Municipal Council have approved of a contract with the Italian Edison General Electric Lighting Company for the electric lighting of the principal streets in the centre of that city. It is believed that the installation will be completed three months hence.

London Chamber of Commerce.—The following were elected members of the London Chamber of Commerce at the February Council meeting:—National Telephone Company; Frank Suter and Co., electrical engineers and contractors; Isaac Stow (R. C. Cutting and Co.), electrical engineer.

Dresden.—The Town Council of Dresden has requested Messrs. Siemens and Halske to submit a scheme for a central station. The station is to be built outside the town, as the authorities have not consented to relieve the town from the stringent regulations as to the erection of boilers.

Football.—Notts National Telephonic *v.* Sheffield National Telephonic.—Teams representing these towns met on Saturday last at Nottingham. A violent downpour of rain brought the match to a premature conclusion, ten minutes yet remaining to play, leaving Notts with a score of four to Sheffield none. On the 22nd inst. Notts pay the return visit.

Selby.—At the last meeting of the Selby Local Board of Health a resolution was passed that the Clerk should communicate with some electric lighting company, and ascertain the cost of providing the electric light in all public thoroughfares and in all public and private buildings now lighted by the Selby Gas Company within the district of the Selby Local Board.

The Verity Cricket and Football Club.—The Cricket and Football Club in connection with the firm of Messrs. B. Verity and Sons, of Covent Garden, on Friday evening gave their third annual smoking concert at the "Horseshoe"; Mr. J. B. Verity being in the chair. There were between two and three hundred persons present, and the meeting was an unqualified success.

Eastern Extension, Australasia and China Telegraph Company (Limited).—Particulars are given on page xv. of advertisements of the drawing of 125 bonds of £100 each of the Five per Cent. Debentures (1880 issue) of this Company. These debentures will be paid off at par on the 1st day of May next, at the Consolidated Bank, 52, Threadneedle-street, E.C., after which date interest on them will cease.

Royal Institution.—The following are some of the lectures arranged for after Easter:—Prof. C. V. Boys, three lectures on "The Heat of the Moon and Stars"; Prof. Dewar, six lectures on "Flame and Explosives"; Captain Abney, three lectures on "Colour and its Chemical Action." The Friday evening meetings will be resumed on April 18th, when a discourse will be given by Sir Frederick Bramwell, Bart., on "Electric Welding."

Reading.—At the last meeting of the Town Council, the Special Committee recommended that the Council should give consent to an application to the Board of Trade by the Laing, Wharton, and Down Construction Syndicate (Limited) for a licence to supply electricity for lighting purposes within the borough, subject to the terms and conditions of the licence being approved by the Council. The report was agreed to.

Damage by Lightning.—The *Journal Télégraphiste de Berne* of February 25th publishes a list of the cases of damage done by lightning to telegraph and telephone wires during 1888. In France 647 poles were struck, 347 being afterwards useless. In Germany 787 poles were struck, but only 266 were so badly damaged as to necessitate their renewal. In Germany 94 insulators were injured during the year, while in France the number reached 812.

Folkestone.—At the last meeting of the Corporation there was a debate on the subject of the electric light. The contract with Messrs. Crompton and Co. binds them to complete the arrangements for lighting the west end of the town by July next. Messrs. Crompton and Co. have applied for an extension of time for six months. It was decided that the application should be refused, and that the firm should be held to the terms of the contract.

Leamington.—At the last meeting of the Town Council the Mayor and Aldermen Wackrill and Gilbert presented a voluminous report on the inquiries they had made as to the working of the electric light in London. The deputation recommended that the Council should apply for a Provisional Order to enable them either to carry out works of their own or to license a company with whom they would be able to arrange suitable terms. The report was adopted.

Municipal Authorities and Electric Lighting Orders.—The annual meeting of the Association of Municipal Corporations took place on Wednesday last at the Guildhall, and was largely attended. The Town Clerk of Hull moved: "That the President of the Board of Trade be asked to receive a deputation from this Association upon the subject of electric lighting powers as affecting local authorities." The Town Clerk of Manchester seconded the motion, which was carried.

Smokeless Fuel for Generating Steam.—We notice by the Patent Records that a provisional patent has been granted to Mr. Arthur Shippey, for "Improvements in Compound Fuel for Preventing Smoke and Methods adopted for obtaining an Incandescent Fuel for Generating Steam and the Production of Heat." If Mr. Shippey succeeds in placing on the market a really smokeless fuel, it will, no doubt, lead to an increase in the number of small central lighting stations built in populous districts.

Edinburgh Exhibition.—A meeting of the Executive Council of the Exhibition was held on Friday last. It was reported that it had been arranged that a Chemin de Fer Glissant would be on exhibition. A considerable number of further subscriptions to the guarantee fund were announced. The Council resolved to have an electric railway, the contract for which will be proceeded with at once, Mr. Bennett being entrusted with the arrangement as to the number of cars to be used and the trains.

The Electric Light in Factories.—At the meeting of the shareholders in Cassell and Co. (Limited), held on Tuesday, Mr. R. Turner, the chairman and managing director, observed that fair space and working convenience were long a cardinal principle with the old firm (Messrs. Cassell, Petter, and Galpin), and it was still held; and the directors now had in view the possibility of further improvement by the substitution of electricity for gas throughout the whole of the offices.

The Institution of Electrical Engineers.—The students of the Institution held a meeting last Friday at the Sanctuary, when Mr. H. Walker read a Paper on "Ship Lighting," Mr. W. M. Mordey occupying the chair. A short discussion followed, in which the Chairman, Messrs. Muir, Stephens, Poynton, Horn, and Cirlo took part. Mr. Walker having replied, a vote of thanks to the chairman terminated the proceedings. At the next meeting, to be held on the 21st inst., Mr. R. Wightman will read a Paper on "Constant-Current Regulators."

Central London Railway Bill.—At the last meeting of the London County Council Mr. Beachcroft moved, "That,

Digitized by Google

as no resolution had been come to by the Council to oppose the Central London Railway Bill on its merits, and as the object of the Bill, if successfully attained, will effect a great metropolitan improvement without a charge upon the rates, the opposition of the Council to such Bill be confined to the taking of needful steps to secure the special clauses required to protect the sewers and other works of the Council." This resolution was adopted.

Croydon.—A special meeting of the County Council was held on Monday evening to consider the expediency of consenting to the Provisional Orders promoted by the Croydon Electric Supply Company, the South of England House-to-House Electricity Company, and the Crystal Palace and District Electric Lighting Order. Councillor Miller explained that the Council had already decided that the Orders promoted by the Croydon Electric Supply Company and the South of England House-to-House Supply Company should not be agreed to, and moved that consent should be given to the last Order. The resolution was carried.

Newcastle.—The Newcastle and District Electric Company are now supplying 26 customers, the total number of lights being equal to about 2,000 10 candle-power lamps. In addition to this the Company are supplying the current for 500 lamps at Deuchar's Rooms, Barras Bridge, and by the end of this month or the beginning of next it is anticipated that fully 5,000 lamps will be connected to the mains. The Newcastle Electric Supply Company are very busy, and the difficulty they experience is not so much in getting contracts as in confining their operations to a given district. The light, wherever it has been introduced, is reported to have given every satisfaction.

Trial Trip of the Twin-Screw Cable Steamer "Relay."—On Saturday this fine steamer, particulars of which will be found in our issue of January 31st, had her official trial at sea for six consecutive hours. Everything worked satisfactorily. During the trial luncheon was served in the saloon, the following gentlemen being present :—Mr. J. E. Thompson (of the firm of Robert Thompson and Sons), Mr. J. R. France, Mr. H. Clark (representing George Clark, Limited, builders of engines), Captain Lugar (who will take command), Mr. Rosser (inspector for the owners for both ship and machinery), Mr. Watt (Board of Trade surveyor), Mr. Hildrey (chief draughtsman to the builders), Mr. Cay (outside manager to engine builders), and a large party of friends.

Edinburgh.—We cull the following from a long and interesting article on the present position of the electric lighting question in Edinburgh, which appeared in the *Scotsman* of March 6th :—"Granted in our own case, therefore, that the Board of Trade insert in the Provisional Orders they recommend for the confirmation of Parliament, sufficient clauses protecting all public interests in our street management, all our public works, and the safety of our persons, fixing a reasonable maximum charge for the commodity to prevent abuse or unrestricted monopoly in our city, and placing a right of superintendence and supervision of the supply in the hands of our Town Council, what more do we, as ratepayers and citizens, require if a good company be selected?" What more indeed!

Brighton.—At the last meeting of the Town Council a renewed attempt to obtain the immediate removal of Mr. Magnus Volk's electric railway was defeated. At the same meeting the proceedings of the Pavilion Committee were read. They contained the award of Mr. A. M. Channell, Q.C., in the disputes between the Corporation and Maxim-Weston Electric Company, in respect to the contract for reconstructing the electric lighting works at the Pavilion. It was found after going through the accounts there was due from the contractors to the Corporation £6. 5s. 10d. The contractors are to pay the costs of the award. The proceedings of the Lighting Committee recorded a refusal on the part of the Committee to consent to an interview with Mr. R. Hammond, of the Brighton and Hove Electric Lighting Company, and also that the offer of the Company to light the front at the same price as the Corporation were paying for gas, was declined.

Telephonic Development in the West of England.—The Western Counties and South Wales Telephone Company announce that they are prepared to open exchanges at Tavistock, Horrabridge, Yelverton, Gunnislake and Calstock. These places would be connected with Plymouth, and thus be placed in communication with Plympton, Ivybridge, Avonwick, Torquay, Totnes, Brixham, Buckfastleigh, Dartmouth, and Ashburton. A meeting to consider the matter was held at Tavistock Guildhall, on Wednesday last, and it is hoped that sufficient support will be forthcoming to justify the proposed extension of the telephone. A still further development is under consideration, and will be carried into effect during the year if the Company receives sufficient support. It is contemplated to erect trunk lines between Newton Abbot, Dawlish, Teignmouth, Exeter, Taunton, Bridgwater, Weston-super-Mare, and Bristol, connecting these towns with the already established system from Bristol to Bath, Cheltenham, Gloucester, Newport, Cardiff, the Rhondda and Ebbw Vale coal districts, Swansea and Llanelly.

The London County Council Subways and Overhead Wires Bill.—No fewer than thirty-six petitioners have, within the time limited by the Standing Orders, deposited petitions in the Private Bill Office of the House of Commons praying to be heard in opposition to the passing of the Bill promoted by the London County Council for constructing subways for pipes and wires under the streets of the metropolis, and for the creation of an efficient system of control over overhead wires and cables. Although this number of petitions is greater than any number that has yet been deposited against any English Bill now before Parliament, it does not fully represent the strength of the opposition which this Bill will have to encounter, inasmuch as the London Water Companies and a large majority of the Electric Light Companies have consolidated their oppositions and are represented by only two out of the thirty-six petitions lodged against the Bill. An analysis of the petitions shows that among the opponents are thirteen railway companies, ten local and other governing authorities, five gas companies, and six telephone, hydraulic and other companies.

The Board of Trade on Electric Lighting Bills and Orders of 1890.—The Board of Trade Report on Electric Lighting and other Bills has been published, and according to it there are eight Electric Lighting Bills in England and Scotland, with a combined proposed capital of £70,000, of which £20,000 relates to English, and £50,000 to Scotch Bills. The applications for Provisional Orders for Electric Lighting amount to 161, with a proposed estimated capital of £9,242,828, of which English companies absorb £7,908,000, Scotch £1,131,000, and Irish £203,000. Of the English companies the largest in point of capital (£300,000) is that of the Westminster Electric Supply Corporation, seeking to supply electricity for public and private purposes in the parishes of Paddington and St. Marylebone; the smallest is that of the Electric Trust in Bognor, which proposes to supply electricity within the Local Board district of Bognor, with a capital of £4,000. In Scotland, Aberdeen proposes to have two installations, one by the Town Council and one by the Scottish House-to-House Electricity Company; while in Ireland Provisional Orders are applied for in Belfast, Cork, Londonderry, and Galway.

St. Pancras Vestry.—At the last meeting of this Vestry the Dual Committee of the Parliamentary and General Purposes and the Lighting Committees presented a report upon the action taken by them respecting electric lighting. In the first place they gave up all idea of taking the premises in Edward-street, held by the Vestry for a short lease, and also a site in the King's-road, as both were considered unsuitable. It was thought by the Committee that it would be most desirable to obtain a freehold; and they had found an estate in Stanhope-street of 22 houses, for which one of the electric lighting companies had offered £13,000, but had not completed owing to the action of the Vestry in refusing to have private companies to compete. The site contained 20,600 superficial feet, and could be had for £10,000; while Edward-street, with only 12,000ft. area, would cost £15,000. Without pulling all the houses down they would have sufficient room with half, so there would be an income from ten houses of about £300 a year; this in forty years would pay the principal and interest without costing the ratepayers one halfpenny, and at the end of that period the parish would be the possessor of this estate that had cost them nothing.

Digitized by Google

MAGNETISM IN IRON AND OTHER METALS.*—IX.

BY PROF. J. A. EWING, F.R.S.

(*Continued from page 442.*)

§ 46. **Magnetisation Curve.**—A convenient way of representing such results graphically is to draw a curve showing the relation of the magnetising force to I or to B. In Fig. 20 a curve showing the relation of the magnetising force of the solenoid to I is drawn from the above table. O A B is the ascending limb got by applying a magnetising current, the iron being originally in a non-magnetised and perfectly neutral state. From B to C the magnetising current is being reduced to zero from C to D an increasing negative current is being applied

This example is thoroughly characteristic of the behaviour of annealed wrought iron. The ascending limb of the curve may be divided, broadly, into three portions. In the first, under feeble magnetic forces, the gradient of the curve is very small, which means that at this stage there is (comparatively) very little magnetic susceptibility.† Later, as the force increases, the curve becomes exceedingly steep, and nearly straight; this is the region of great susceptibility. Then, lastly, the curve rounds off until the rate of ascent again becomes small, so that the susceptibility diminishes, and any considerable addition to I can then be brought about only by applying a very strong magnetising force.

This third stage is a necessary consequence of the well-known phenomenon of magnetic "saturation." We shall see later that the value of I has a definite limit which cannot be exceeded no matter how high the magnetic force be raised.

§ 47. **Residual Magnetism and Coercive Force.**—In the descending limb of the curve it is interesting to notice how little of the magnetism disappears as the magnetic force is withdrawn. Even when the solenoid current is reduced to zero, the residual magnetism O C is in this case 1,162 C.-G.-S. units, which is no less than 92 per cent. of the value reached when the current was on (1,262 units). This residual magnetism is, however, very feebly held. Applying a reverse magnetic force quickly removes it, as the continuation C D of the descending limb shows, and a force, O D, of − 2·75 C.-G.-S. units suffices to destroy it altogether. This force O D may be said to measure the degree of stability with which the residual magnetism is held, and accordingly Dr. Hopkinson calls it the "coercive force," thus giving an exact and very useful meaning to an old loosely applied term.

§ 48. **Correction of the foregoing results to allow for the reaction of the Specimen on the Magnetising Field.**—When the specimen is so long as it was in this instance (400 diameters), its ends have no great influence on the field, and we might without any serious error ignore the difference between H′ and H, and take the magnetising force of the solenoid to represent the whole magnetic force. The approximate allowance for the effect of the ends may, however, be made by treating the specimen as an ellipsoid.* By § 33 we have, in that case,

$$H = H' - 0{\cdot}00045\ I.$$

Thus, for instance, the magnetic force producing a magnetisation of 1,000 is, on this basis, 0·45 units less than the force due to the solenoid, and for other values of I a proportional correction is to be made. We may therefore allow for this in the diagram† (Fig. 20) by drawing a straight line, O E, from O to cut the line of I = 1,000 at a force of 0·45. Then the true value of H for any point in the curve of magnetisation is to be measured from this line, instead of from the line O C. In other words, the effect of the ends of the specimen is to *shear* the diagram in the direction in which H is drawn, through the angle C O E; and we may deduce the corrected curve from the original curve O A B by setting each point, such as A, back through a distance A A^1 equal to the distance between O E and the axis O C for the corresponding value of I. The same construction obviously applies to the descending limb. The dotted curves O A^1 B and B C^1 D have been drawn in this way, and they may be accepted as giving a more nearly correct representation of the relation of I to H than is given by the original curves.

One effect of the change is to make the susceptibility greater: its maximum value (which is found by drawing a tangent from O to the curve) rises from 189 to 209. Another effect is

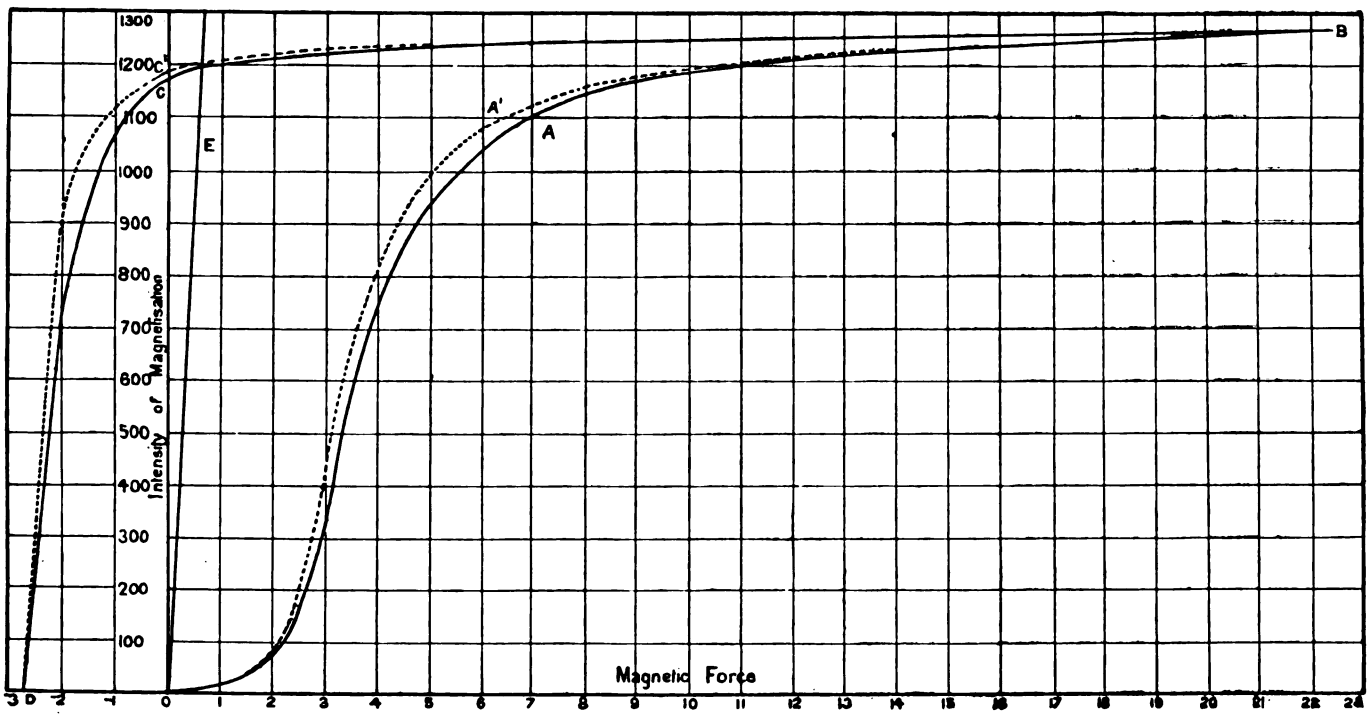


FIG. 20.—Curve of Magnetisation in Annealed Wrought Iron.

* All rights are reserved.

† The comparatively small susceptibility of iron to feeble forces seems to have been first clearly pointed out by Stoletow (*Phil. Mag.*, Vol. XLV., 1873, p. 40), whose observations on the relation of magnetisation to magnetic force were confirmed and greatly extended by Rowland (*Phil. Mag.*, Vol. XLVI., 1873, p. 140; and Vol. XLVIII., 1874, p. 321).

* Probably this correction is rather excessive. In a cylindrical rod the magnetism is more nearly concentrated at the ends than in an ellipsoid. Its effect on the magnetic force is unequal at different parts of the length, but its mean effect may be expected to be less than in the case of an ellipsoid.

† This construction is used by Lord Rayleigh in a Paper on "The Energy of Magnetised Iron" (*Phil. Mag.*, Vol. XXII., 1886, p. 175.)

Digitized by Google

to increase the residual magnetism, making it 93·8 per cent. of the induced magnetism instead of 92·1 per cent. Another effect is to increase the steepness of the gradient in the steep part both of the ascending and of the descending limb.

Table II. gives the results of the same experiment (for the ascending process) on the supposition that the correction of H to be made on account of the ends of the specimen does not sensibly differ from the correction which would have to be made in an ellipsoid 400 (equatorial) diameters long. Values of B, μ and κ are given as well as I and H. B, which is $4\pi I + H$, is so nearly equal to $4\pi I$ that we might adapt the curve of Fig. 20 to exhibit the relation of B, instead of I, to H, by simply altering the scale of the ordinates, so that 100 of I should represent 1,257 of B.

TABLE II.

H	I	$\kappa = \frac{I}{H}$	B	$\mu = \frac{B}{H}$
0	0	—	0	—
0·32	3	9	40	120
0·84	13	15	170	200
1·37	33	24	420	310
2·14	93	43	1,170	550
2·67	295	110	3,710	1,390
3·24	581	179	7,300	2,250
3·89	793	204	9,970	2,560
4·50	926	206	11,640	2,590
5·17	1,009	195	12,680	2,450
6·20	1,086	175	13,640	2,200
7·94	1,155	145	14,510	1,830
9·79	1,192	122	14,980	1,530
11·57	1,212	105	15,230	1,320
15·06	1,238	82	15,570	1,030
19·76	1,255	64	15,780	800
21·70	1,262	58	15,870	730

§ 49. **Differential Susceptibility and Differential Permeability.** In many cases we are less concerned to know the actual ratio of I or of B to H than to know the rate at which I or B is increasing or diminishing with respect to H—in other words, the gradient of the magnetisation curve. We have seen that the gradient $\frac{dI}{dH}$ begins by being small, then becomes very large, and then again becomes small as the region of saturation is approached. Prof. Knott has proposed to call this quantity the "differential susceptibility"; similarly $\frac{dB}{dH}$ may be called the differential permeability. In the example which has been quoted, the differential susceptibility (after applying the ellipsoidal correction) has a maximum value in the ascending limb of 530, which is sensibly constant, while I changes from, say, 150 to 650. The corresponding differential permeability is 6,660. In the descending limb the greatest differential susceptibility is 1,660, and this is sensibly constant, while I changes for 700 to 0 (and to − 700, as we shall later see in other examples). The corresponding differential permeability is 20,850.

(To be continued.)

REVIEWS.

"Practical Notes for Electrical Students." Vol. I. By A. E. KENNELLY and H. D. WILKINSON. [THE ELECTRICIAN Printing and Publishing Company (Limited).]

This book is mainly a reprint of the excellent series of articles entitled "Letters for Learners and Unprofessional Readers," which were commenced in *The Electrician* towards the close of the year 1887. It is designed, as the title of those articles implies, chiefly for those who are but slightly grounded in electrical matters, and with this view the authors have endeavoured to render their language as simple as possible, and to exclude all mathematical expressions. In this attempt the authors have succeeded very well, and the practical nature of the matter will render it of service to many readers beside those for whom the book is professedly written.

The work is divided into nine chapters, whose unequal length is due, partly to the fact that the matter was originally written as serial articles for the press, and partly because these were commenced by one of the writers and finished by the other. The introductory chapter is well designed to impart correct notions of the fundamental principles underlying electrical measurements. The elementary definitions are referred directly to energy considerations, the importance of which is the first thing pointed out. Thus the quantity of electricity produced by a voltaic cell is connected with the quantity of electrode consumed, and the electromotive force of the cell with the energy developed chemically by the consumption of the unit quantity of the electrode. The second chapter treats critically of the various kinds of batteries used in practice. The Latimer Clark standard cell is mentioned, but its E.M.F. is stated incorrectly, and its high-temperature coefficient is not given at all. The internal resistance of this cell is generally supposed to be immaterial, owing to the belief that no appreciable current should be taken from it. Prof. Threlfall has, however, found that the constancy of the E.M.F. may be relied on when the internal resistance is small, even if moderate currents are sent by the cell. The third chapter is devoted to electromotive force and potential. Graphical processes are freely used to illustrate the distribution of potential in various combinations of batteries. The following chapter on resistance exemplifies an excellent characteristic of the book, the subject matter of which is constantly being rendered clear by means of numerical examples fully worked out. The authors, instead of using symbols in their mathematical expressions, have, wherever possible, used the actual numbers taken from a typical example. The expressions so obtained serve the same purpose as formulæ, and, no doubt, seem simpler to many. Sir William Thomson's convenient, but very ugly word *mho* is introduced to represent the unit of conductivity, and the laws of parallel resistances are thereby rendered very simple. As, however, the qualities of a circuit are in practice defined by its resistance in ohms, not by its conductivity in *mhos*, too much prominence is given to the latter quantity. This is more especially the case because Ohm's law is not mentioned till the next chapter, and even then the law is stated more as a definition of resistance than as an experimental fact. It is purely an experimental matter to show that the ratio of the difference of potential required to make electricity flow through a conductor to the strength of the current produced is a constant for the same conductor whatever potentials and currents are employed. That this ratio, which is called the resistance of the conductor, is a constant, and corresponds to some physical property of the wire independent of current, is the really vital part of Ohm's law. It is not enough to state, as the authors do, that the current in amperes is obtained by multiplying the E.M.F. in volts by the conductivity in *mhos*, or, as is more usual, by dividing the E.M.F. so expressed by the resistance in ohms.

The properties of electric currents are illustrated by reference to the closed circuit system of telegraphic signalling and to the phenomena of retardation in connection with submarine cables. The next chapter, dealing with the subject of current indicators, is important. Many practical forms suitable for use with various kinds of work are described and illustrated by numerous engravings. The winding of the bobbins and the methods for supporting the indicating needle are discussed in detail. The best resistance to wind the instrument for any given purpose is determined by a simple graphical process, thus avoiding the need of any symbolic calculation. The seventh and eighth chapters are of a very practical nature, full of useful hints and such as to quite justify the title of the book. The uses of indicators in testing for continuity, detecting faults, testing for identity of stranded wires, determining insulation resistances, &c., are clearly brought out. Various forms of insulators are illustrated, and full directions for making insulation tests are given. The seventh chapter concludes with a very complete description of the General Post Office standard indicator. The subjects next treated are the calibration of current indicators, the use of calibration curves, the functions of shunts, and calculations connected with them.

Digitized by Google

The concluding chapter, which is longer than the rest of the book put together, deals with magnetic fields and their measurement. Free use is made of iron filing figures to explain the phenomena of lines of force. The fact that these figures only indicate the lines of force outside the iron, and that consequently they fail to exhibit the closed ring character of the lines, might with advantage have been definitely stated here. The continuous nature of the lines is, however, brought out clearly later on in the book. The different magnetic units are defined and discussed, their mutual relations being clearly brought out by means of numerical examples. The mechanical principles necessary to understand in connection with the reactions of magnets and magnetic fields are explained. The magnetometer method of comparing magnets is next discussed. Very simple forms of the instrument are described, and the various parts are illustrated by engravings, so that the reader may easily, if he chooses, make the apparatus and carry out the experiments for himself. The molecular nature of magnetism is vividly shown by an account of Prof. Hughes' interesting researches. The second section of the chapter treats of electromagnetic fields. The numerous uses of electromagnets in telegraphy are described, and an explanation is given of the device for diminishing the time constant of electromagnets by winding the two magnetising coils in parallel. The influence of iron cores and the properties of magnetic circuits are very completely shown by means of a good series of experiments made by Mr. Wilkinson. The inductive properties of iron, and the short-circuiting effect on the lines of force produced by putting an armature across the poles of an electromagnet, are clearly brought out. The subjects of permeability and susceptibility are described in simple language, and made clear by a detailed account of many series of experiments made by one of the authors, and also by a summary of the classical researches of Ewing. The book concludes with a discussion of the nature of the magnetic fields of coils and solenoids.

The book is throughout very fully illustrated by excellent engravings, and the authors may be heartily congratulated on their success in describing in a simple, thorough, and practical way the matter they have dealt with. W. E. S.

TELEPHONIC SPECIFIC INDUCTIVE CAPACITY.*

BY F. H. SAFFORD AND G. U. G. HOLMAN.

In a Paper on the "Construction of Telephone Circuits," read before this Academy on June 15, 1887, by the electrician of the American Bell Telephone Company, Dr. Jaques, it was pointed out that the readiness with which telephonic conversation may be carried on over any circuit, whether made up of cables or pole lines, or both, depends :—

"1. On the total electrical resistance of the circuit joining together the two stations.

"2. On the electrostatic capacity of this circuit."

And the general rule was laid down :—

"No matter what may be the distance between two points, good business conversation may be carried on between them, provided they be connected by a pole line or cable, or both, the product of whose total resistance by its total capacity is less than 2,000 if transmitters of the Blake type be used, and less than 4,500 if transmitters of the Hunnings type be used."

It is evident, therefore, that in the construction of a telephone line it is desirable to reduce both the *resistance* and the *capacity* to a minimum. In a pole line, since the wire is suspended high above the earth, the capacity is always small, and the resistance is the factor that we must try to keep down. In cable lines, however, the capacity becomes a factor to be respected. In lines made up, as is most generally the case, of a comparatively short section of cable and a larger section of iron pole wire, the capacity of the cable becomes pre-eminently the factor to be respected ; for, since the limit of conversation is here determined by the product of the capacity of the cable and the resistance of the whole line, a small percentage of saving in the capacity of the cable gives an enormous gain in the readiness with which conversation may be carried on over the line. It becomes of vital importance, therefore, to choose an insulating material for telephone cables of low specific inductive capacity.

* Paper read before the American Academy of Arts and Sciences.

We have accordingly measured the electrostatic capacity of a considerable number of substances used for insulating wires in cables, and, since the specific inductive capacity for the same insulator is very different for telephone currents from what it is for telegraph currents, because the charge and discharge take place so much more frequently, we have adopted a method and apparatus in which currents of telephonic frequency are used. This apparatus is a Gordon induction balance, in which the substances were charged and discharged by currents from an induction coil, and the balance was observed with a telephone instead of an electrometer.

With this apparatus, we measured the specific inductive capacity of a considerable number of insulating materials, and each when subjected to various rates of charge. We found that the capacity varied very materially with the rate of charge, some substances increasing and others decreasing ; but no general rule was evolved. We found that measurements of the capacities of telephone cables made by the ordinary galvanometric measurements gave no indications of the comparative merits of these cables for telephonic work. Finally, we made an accurate series of measurements of the specific inductive capacity of the following substances, when submitted to actual telephone currents. The values might perhaps be called the "telephonic specific inductive capacity," leaving the expression "telegraphic specific inductive capacity" to indicate values measured in the old-fashioned way.

TABLE OF SPECIFIC INDUCTIVE CAPACITIES, MEASURED BY TELEPHONE CURRENTS.

Petroleum (Brooks cable)	1·6
Solid paraffin	2·0
Cotton saturated with paraffin in vacuum (Faraday cable)	2·0
Cotton boiled in paraffin (Patterson cable)	2·6
Indiarubber	3·7
Artificial gutta percha (Gwynn)	3·9
Gutta percha	4·2
Glass	4·6
Water	6·3

An inspection of this table shows that, so far as capacity is concerned, petroleum is the best substance to be used, and doubtless this would be the case were it possible to keep it free from water ; but water, we see from the table, has a specific inductive capacity of 6 3, so that its presence in the petroleum raises the capacity from the lowest to the highest in the list. This observation is borne out by actual experience with "Brooks" cables in telephony. When new, and the petrolum dry, it works excellently ; but as water finds its way in, the cable rapidly loses its efficiency for telephonic work. This action of the water is quite different from its action as a *conductor* to produce leakage ; for the loss of electricity due to leakage in a "Brooks" cable that has lost its efficiency from the presence of moisture is entirely insufficient to account for the deterioration.

Next to petroleum, solid paraffin is seen to be the best substance to use ; but on account of mechanical difficulties it has never been found practicable to coat wires directly with solid paraffin. If the wires are wound with cotton and then boiled in paraffin, as they are in making "Patterson" cables, the specific inductive capacity is raised to 2·6, an increase of 30 per cent., which we have seen is a very great detriment. If, however, the wires are wound with cotton, and the air and moisture removed by the aid of heat and a vacuum, and they are then boiled in paraffin, from which the air and moisture have also been removed by heat and vacuum, the specific inductive capacity again falls to 2·0, which is the same as that of solid paraffin. This process is used in preparing the "Faraday" cable. It is possible that the inferiority of the "Patterson" cable as compared with the "Faraday" is due largely to the moisture retained in the cotton, which we have seen has a capacity of 6·3.

Leaving the paraffin cables, rubber is the next best, then gutta-percha, and poorest of all is glass ; but all of these substances have so high a specific inductive capacity as to entirely unfit them for telephonic work.

CONTINUOUS OUTPUTS OF TWO-POLE DYNAMOS AND MOTORS.

BY ALBION T. SNELL.

The following equations are intended for the use of engineers in charge of electrical plant, and demand no special electrical knowledge, the measurement being made by a foot-rule. They give approximately the safe average output of dynamos and motors *for continuous running*, and are based on observations made during the past few years with machines of nearly all the best manufacturers. They, of course, only average the results, and so will not

Digitized by Google

give a sufficiently high output for machines of abnormal proportions, *i.e.*, with unusually heavy fields, or very deep armature cores. With very light machines the formulæ will give results too high.

With normal machines the outputs given by these equations will generally be about 10 per cent. lower than that given in the price lists. This margin is made to meet the contingencies incidental to continuous running.

The outputs are expressed in terms of the armature lengths and diameters and the numbers of revolutions per minute. The constants are carefully determined from a large number of tests. (They depend on the fact that the average magnetic induction through an armature is determined by the effective area of the iron and the magnetic density per unit area. For a given field excitation the total induction will be sensibly constant through considerable variations of radial depth of armature. This is apparent when we consider that the conductivity of the armature iron bears but a small proportion to the conductivity of the magnetic circuit as a whole, and hence an increase of iron will not largely increase the total induction, but will almost always decrease the induction per unit area.) The outputs of dynamos are given in watts (746=1 horse-power). Those of motors are given in brake-horse-power. The linear measurements of the armatures are made in inches. l=the length of the armature parallel to the shaft. In the case of cylinders the length may be taken over all, *i.e.*, from one end of the winding to the other. In drums, only that part of the armature covered by the pole-pieces must be measured for the value of l. The outer diameter d of the armature is measured over the windings. The revolutions per minute can be taken by a speed indicator or counter.

For two-pole dynamos:

l=length of armature in inches.

d=diameter of armature in inches.

r=number of revolutions per minute.

Drum armature: $l\,d^2\,r\,\cdot 015$=output in watts . (I.)

Cylinder armature: $l\,d^2\,r\,\cdot 01$=output in watts . (II.)

For two-pole motors: (Symbols have the same signification.)

Drum armature: $l\,d^2\,r\,\cdot 000015$=B.H.P. . . . (III.)

Cylinder armature: $l\,d^2\,r\,\cdot 00001$=B.H.P. . . . (IV.)

With a four-pole machine, since for the same magnetic density in the armature double the field excitation required for a two-pole machine is necessary, the *constant* must be multiplied by *two*. Some four-pole machines, however, have very light fields, and then the output is given nearly correctly by the formulæ. Generally, with machines of more than two poles the equations will only be useful for determining the safe load for a *first run*. If the heating be very little the output can then be gradually increased until a suitable load be obtained.

The following examples, chosen at random, show the method of applying the formulæ to various machines:—

Edison-Hopkinson Dynamo.—Drum armature, 9¾in. in length, 10in. in diameter, 970 revolutions per minute.

Equation (I.)

$$9{\cdot}75 \times 10^2 \times 970 \times {\cdot}015 = 14{,}200 \text{ watts.}$$

The output is given at 15,700 watts.

Paterson and Cooper Dynamo.—Cylinder armature, 10in. in length, 13·5in in diameter, 850 revolutions per minute.

Equation (II.)

$$10 \times 13{\cdot}5^2 \times 850 \times {\cdot}01 = 15{,}500 \text{ watts.}$$

The actual output is given at 16,200 watts.

Immisch Motor.—Drum armature, 14in. in length, 7·25in. in diameter, 1,000 revolutions per minute.

Equation (III.)

$$14 \times 7{\cdot}25^2 \times 1000 \times {\cdot}000015 = 11 \text{ B.H.P.}$$

This machine is actually designed to give 10 B.H.P.

Immisch Motor.—Cylinder armature, 16in. in length, 24·5in. in diameter, 450 revolutions per minute.

Equation (IV.)

$$16 \times 24{\cdot}5^2 \times 450 \times {\cdot}00001 = 43{\cdot}2 \text{ B.H.P.}$$

The actual horse-power given continuously by this motor is between44 and 45.

The writer has found these equations of great assistance in selecting the size of armature for a given machine, before making more complete calculations.

CARBON TESTS.*

BY E. F. PECK.

The first electric light of any consequence was used by Sir Humphry Davy in 1810. He had discovered that when the two terminals of a charged electric circuit were separated a short distance, an electric spark would pass between these terminals by evaporising the material of which the electrodes were composed, and that the vapour thus produced would continue to carry the current between the electrodes, and that these vapours, together with the highly incandescent solid ends of the electrodes, would emit a powerful light. The vaporised material bridging the space between the terminals of the electric circuit he denominated the electric arc, for the reason that these vapours would pass in a curved path between the two electrodes. Sir Humphry Davy demonstrated this interesting phenomenon by using a great variety of material for the electrodes; and he found that the most brilliant effects were produced when the electrodes were made of carbons. The carbon used by him was charcoal made from various woods. It was found, however, that the charcoal, from whatever wood it was made, always had a considerable electrical resistance, and was so rapidly consumed that it could not be used for the production of arc lights for practical purposes, such as general illumination.

Other electricians took hold of Sir Humphry Davy's discovery, and their efforts were directed towards the discovery of materials for the production of electrodes of greater durability and better conductivity. It was finally discovered that carbon deposited in the neck of gas retorts possessed a higher degree of conductivity and was exceedingly hard, and therefore would be very durable when used as electrodes for arc lights. Rods or pencils of this gas-retort carbon were made and shaped at great expense and trouble, and they were found to be excellent substitutes for the charcoal electrodes. Still these gas-retort carbons could never be used on a large scale, for the reason that they could be shaped to the required form only at a very great expense, being exceedingly hard. The next step in the improvement of carbon electrodes for arc lamps was made in 1842, when Bunsen invented what he called the "plastic" carbon as the negative electrode of his battery. This carbon electrode was made of various mixtures of powdered charcoal, molasses, &c. It could be shaped to any desired form, and was made by Bunsen in the shape of hollow cylinders and flat plates. When it was found that this carbon electrode could be used to advantage for the production of electric arc lights, it was at once substituted for the gas carbon. This substitution was not a universal one; for as late as 1873 and 1874 Prof. Tyndall was in the habit of using gas-retort carbons in the production of electric arc lights, although he complained bitterly to his audiences that the production of his carbon electrodes involved great expense and trouble. The carbons burned at the Centennial Exposition in 1876 were of this material, but we have no data of their life or resistance. They were made by Carré of France, and the current was from a Gramme machine.

From 1842, when Bunsen invented his "plastic," or moulded carbon, to 1879, many inventors of this country and Europe tried to improve on his discovery. Their chief object was to produce a carbon of greater and more uniform density, and of higher conductivity. The English patents were especially numerous during this period, and their mixture in the more enlightened state of the art seems very ludicrous. Though some laboured at the problem nearly fifteen years, on the whole no great improvement was made. This poverty of result was largely due to the fact that the dynamo apparatus of to-day was unknown. All arc lights were produced by currents generated by batteries. The modern arc lamp, with its simple but effective mechanism, was unknown. The arc light was only a curious laboratory plaything, generated expensively and burned disadvantageously. The proper experimental condition to enable an inventor to produce good carbons did not exist, and the financial stimulus of commercial demands was wholly absent.

The modern arc light carbon of commerce is hardly ten years old. It became a necessity as soon as the modern dynamo apparatus was completed, and commercial lighting by electricity was seen to be coming in the near future. The problem may be said to have been undertaken in 1878. The first point was to discover crude carbon that was both pure and cheap. At the suggestion of Mr. Fayette Brown, of Cleveland, Ohio, his son, Mr. A. E. Brown, then experimenting for the Brush Electric Company, tried residue from petroleum. Careful experiment proved this to be the long-sought-for crude material, nor have the investigations of the past ten years found any better. The next point was to manufacture carbons of the requisite quality. Nearly three years later the Brush carbon was produced. The first cost of these was very high and the demand small. Where carbons are now sold by the

* Read before the National Electric Light Association, Kansas City, February, 1890.

Digitized by Google

hundred thousand, they were then sold by the dozen. Like most new articles, the process of manufacture was roundabout and tedious; consequently, both the cost and market price of carbons ten years ago was very high, the first carbons selling as high as $125 per 1,000. I cannot learn that any tests were made of these carbons for resistance, brilliancy, or even exact life. In those days manufacturers were well satisfied if they could make carbons that would burn fairly well, and gave other considerations very little thought, because they were relatively very unimportant.

Besides Mr. Brush and his associates, there were several others in different parts of the country working at the carbon business on different lines. At Ansonia, Conn., the Messrs. Wallace were experimenting with forced carbons, with much success, following the process of Carré of France. This carbon was very dense and hard, and when sounded gave forth a ring almost like a bell. Not to mention many others, Mr. Thompson of Newark, N.J., was also in the field; but, clinging to gas-retort carbons for his crude material, did not meet with the success achieved by his competitors. Since those early days of experimental work, manufacturers have paid especial attention to reducing the cost, lowering the resistance, and increasing the brilliancy and life of the carbon.

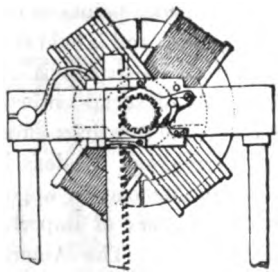
Early in the spring of 1889, at the suggestion of a representative of one of the large carbon manufacturers, I decided to base a year's contract for carbons on the comparative test of the best-known carbons in the market. I made two or three tests, taking into consideration simply the life and resistance of the carbons as adapted to the system of lighting we were using. The tests were rather crude and not made for the purpose of booming any particular carbon, but to satisfy myself as to what carbon I could best afford to burn. The final test was made with a group of Thomson-Houston lamps on a 6½ ampere circuit. Two sets of carbons of each make were placed in the lamps, and each lamp adjusted to the lowest point a quiet arc could be be maintained. A record was made of the time of starting each lamp, and they were then allowed to burn until all the lamps had cut themselves out automatically, by the burning out of the carbons. The electromotive force at the terminals of each lamp was then recorded at intervals of half an hour through the day. The result of the test, stated briefly, was as follows:—

	Nos.	Nos.	Nos.	Nos.	Nos.	Nos.
Lamps.	1 & 2.	3 & 4.	5 & 6.	7 & 8.	9 & 10.	11 & 12.
Average E.M.F.	42·23 ...	42·73 ...	47·16 ...	48·37 ...	47·76 ...	49·66
Average inches burned per hour	1·23 ...	1·46 ...	1·44 ...	1·57 ...	1·72 ...	1·69

As will be seen by this table, there was a difference of 7·43 volts, or a saving of about 15 per cent., in the E.M.F. of the best over the poorest carbon tested, and a difference in life of ·49in. per hour, or a saving of 29 per cent. In a station burning a thousand arc lamps, this means a saving of 64·73 electrical horse-power, without considering the saving in carbons. The figures given above show very plainly the importance of such tests, and I would recommend that superintendents and managers of central lighting stations give this matter their consideration before adopting any special make of carbons.

THE SCHNEIDER ARC LAMP.*

The mechanism of the Schneider arc lamp consists of a toothed rack gearing into a ratchet wheel. Upon the axis of this latter are mounted two coils, one of which is traversed by the main and the other by the shunt current. These coils actuate two semi-circular



cores, arranged with their similar poles opposite one another. The relative influence of the two coils is altered by the variations in the length of the arc: this causes the armatures to rotate and restore the proper distance between the carbons.

* Translated from M. Hippolyte Fontaine's "Éclairage à l'Électricité," by kind permission of the author.

THE CONDUCTIVITY OF VACUUM.*

Dr. James Moser, of the Physical Laboratory of the Imperial University of Vienna, brought the following interesting facts before a recent meeting of the Imperial Academy of Sciences. A Geissler tube was enclosed in another glass tube connected to a mercury pump and placed near to a powerful induction coil serving as a source of electrical oscillations, when the following effects were noticed:—1. When the outer tube was at atmospheric pressure, the inner tube was light blue, and the outer one unaffected. 2. This appearance was reversed as soon as the air in the outer tube was sufficiently exhausted; then the inner tube was dark, the outer one becoming conducting and exhibiting a reddish glow.

The question remained, what would happen if the air in the outer tube were still further exhausted? It is known that the discharge of Geissler tubes with electrodes is diminished at a very high vacuum. The cause of this diminution has been much discussed. Some hold the cause to be the non-conductivity of the vacuum; others attribute it to surface resistance at the electrodes. This experiment makes it easy to decide between these two theories, for there can be no question of electrode resistance, as there are no electrodes. The exhaustion was therefore carried still farther. The outer tube then again became non-luminous and the inner one glowed as at first. Thus it was shown that the more complete vacuum has no screening effect, and loses its conducting power.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-night) FRIDAY, March 14th.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "The Glow of Phosphorus." By Prof. T. E. THORPE, F.R.S.

SATURDAY, March 15th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture: "Electricity and Magnetism." By the Right Hon. Lord RAYLEIGH, F.R.S.

SOCIETY OF ARTS.

3 p.m. Popular Lecture II.: "The Atmosphere." By Prof. VIVIAN LEWES.

MONDAY, March 17th.

SOCIETY OF ARTS.

8 p.m. CANTOR LECTURE IV. 1: "Some Considerations concerning Colour and Colouring." By Prof. A. H. CHURCH, F.R.S.

TUESDAY, March 18th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be read with a view to discussion: "Lough Erne Drainage." By JAMES PRICE, Jun., M.I.C.E.

WEDNESDAY, March 19th.

CIVIL AND MECHANICAL ENGINEERS' SOCIETY.

7 p.m. Paper to be read: "Gold Mining in Merionethshire." By H. C. PAXON, Stud.I.C.E.

ROYAL METEOROLOGICAL SOCIETY.

7 p.m. Ordinary Meeting. Papers to be read: "A Brief Notice respecting Photography in relation to Meteorological Work." By G. M. WHIPPLE, B.Sc. "Application of Photography to Meteorological Phenomena." By WILLIAM MARRIOTT, F.R.Met.Soc.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. "Commercial Geography." By J. S. KELTIE.

THURSDAY, March 20th.

CHEMICAL SOCIETY.

8 p.m. Lecture: "The Evidence afforded by Petrographical Research of the Occurrence of Chemical Change under Great Pressure." By Prof. JUDD, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. Paper to be read at conclusion of the Discussion on Messrs. Swinburne's and Esson's Papers: "Alternate *v.* Continuous Currents in Relation to the Human Body." By H. NEWMAN LAWRENCE, Member, and ARTHUR HARRIES, M.D.

FRIDAY, March 21st.

PHYSICAL SOCIETY.

5 p.m. Papers to be read: "Villari Critical Point of Nickel." By HERBERT TOMLINSON, F.R.S. "Bertrand's Idiocyclophanous Prism." By Prof. SILVANUS THOMPSON, D.Sc.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "Electro-magnetic Radiation." By Prof. G. F. FITZGERALD, F.R.S.

* From the *Zeitschrift für Elektrotechnik*, February, 1890.

Digitized by Google

The Electrician.

Published every Friday. Price Fourpence; Post Free, Fourpence Halfpenny.
Editorial, Publishing and Printing Offices:

SALISBURY COURT, FLEET ST., LONDON, E.C.

Telephone No. 2714. Telegrams: "ELECTRICIAN NEWSPAPER, LONDON."

All Communications to be addressed to "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN."

All letters intended for insertion in "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. Subscribers should receive their copies by the first post on Friday morning.*

"THE ELECTRICIAN" *is on sale at the railway bookstalls throughout the United Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices as above.*

SPECIAL NOTICE.

Owing to the increase in the number of pages of "THE ELECTRICIAN," in order to partly cover the increased postage, we have been compelled to revise the rates for Foreign Subscriptions, which are now as follows:—

	3 months.	6 months.	12 months
For Foreign Parts and Colonies:—	s. d.	s. d.	s. d.
Within Postal Union	6 6	12 6	24 0
Aden, Borneo, Ceylon, China, India, Japan, Java Labuan Mozambique, New Caledonia, Persia, Philippine Islands, Siam, Transvaal, and Zanzibar	7 6	14 6	28 0
The rates for the United Kingdom remain as follows:—	5 0	10 0	19 6

TO ADVERTISERS.

"THE ELECTRICIAN" *offers exceptional advantages to Advertisers.* **It has the largest circulation of any English Electrical paper, and circulates all over the World.**

Particulars relating to Advertisements will be promptly forwarded on application to the office.

TRADE ADVERTISEMENTS *intended for the current issue must be handed in not later than First Post on Thursday morning.*

SMALL PREPAID ADVERTISEMENTS *(for Rates see page xv.) are accepted up to 4:30 p.m. on Thursday.*

TECHNICAL PRINTING.

"THE ELECTRICIAN" PRINTING AND PUBLISHING COMPANY (LIMITED) *beg to inform Electricians, Electric Light Engineers, &c., that they make a specialty of Technical Printing, and have a Staff thoroughly acquainted with Electro-Technology. They can, therefore, promise Accuracy and Despatch in the Printing of Electrical Catalogues and Electro-Technical Literature generally.*

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.

Royal 8vo, 5s., postage extra.

Early in each year is issued "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK. *The Directory was established in 1883, and the 1889 Edition consisted of more than 600 pages of printed matter. The names and addresses of all persons engaged in the Electrical Industries may be relied upon as accurate. Useful Tables and Electrical Formulæ, and information specially compiled for this work are given, together with popularly-written Biographical Notices of the leading Electricians, Electrical Engineers, &c., accompanied in many cases by Portraits.*

The issue for 1890, which is still further enlarged and improved (making 850 pages), is NOW READY. Orders should be forwarded at once to the Publishing Offices, Salisbury-court, Fleet-street, London, E.C.

CONTENTS OF THE CURRENT NUMBER.

NOTES 463
Magnetism in Iron and other Metals.—IX. By Prof. J. A. Ewing, F.R.S. Illustrated. Continued 467
REVIEWS 468
Telephonic Specific Inductive Capacity. By F. H. Stafford and G. U. G. Holman 469
Continuous Output of Two-Pole Dynamos and Motors. By Albion T. Snell 469
Carbon Tests. By E. F. Peck .. 470
The Schneider Arc Lamp. Ill. 471
The Conductivity of Vacuum ... 471
Meetings of Scientific Societies. 471
THE NATIONAL ELECTRIC LIGHT ASSOCIATION 472
OBITUARY—
William Henry Snell 473
The Institution of Electrical Engineers—
Some Points in Dynamo and Motor Design. By W. B. Esson, Member. Illus. Continued 474
The Practical Working of the Electrical Subways of New York City. By William Maver, jun. 477
Standardisation of Potentials on Street Railways 478
American Notes 479
Paris Notes 480
Vienna Notes 480
CORRESPONDENCE—
Electric Traction—A. Reckenzaun 480
The Wynne System of Electric Traction.—Frank Wynne and "C. B. B." ... 481
LEGAL INTELLIGENCE—
Chamberlain and Hookham (Limited) *v.* The Cadogan Electric Light Company (Limited) 482
Radcliff *v.* Great Western Railway Company 482
Trade Notes and Notices 482
PATENT RECORD 483
COMPANIES' MEETINGS, &c.—
Liverpool Electric Supply Company 483
Exeter Electric Light Company (Limited) 485
The Direct Spanish Telegraph Company (Limited) 485
New Companies Registered ... 485
City Notes, &c. 485
Companies' Share List 486

"THE ELECTRICAL WORLD" OF NEW YORK.

"THE ELECTRICAL WORLD" OF NEW YORK *can be obtained from* "THE ELECTRICIAN" *Office, Salisbury-court, Fleet-street, London, E.C. The Rate of Subscription (payable in advance), is* **£1 1s.** *per annum. Single Copies* **price 6d. each; post free, 8d.**

"THE ELECTROTECHNISCHE-ZEITSCHRIFT" OF BERLIN.

In future the above journal (with which has been incorporated "The Centralblatt für Electrotechnik") will be issued weekly instead of fortnightly, the subscription being **£1. 4s. 6d.** *per annum. Single Copies* **6d.; post free, 7½d.**

"THE ELECTRICIAN" PRINTING AND PUBLISHING COMPANY, LTD., *are Agents in Great Britain for both the above well-known journals, and particulars as to Advertisements will be supplied on application to* "THE ELECTRICIAN" PRINTING AND PUBLISHING COMPANY, LTD., *Salisbury Court, Fleet Street, E.C.*

THE NATIONAL ELECTRIC LIGHT ASSOCIATION.

It is to be regretted that we have in England nothing to correspond with the American National Electric Light Association. This rapidly-growing society, which has just held its eleventh convention at Kansas City, performs the same function in the advancement of the electrical industry that the British Association does in the advancement of pure science. These Associations have, in fact, many points in common. Each convention lasts for about a week, and is held successively in various parts of the country. Good fellowship is promoted among the members by various kinds of social entertainment, while the numerous Papers read at the meetings afford the opportunity for a most valuable interchange of ideas between men drawn from all quarters. Each Association appoints several special committees to consider matters of importance, and to report thereon to the next meeting. The American Association is, however, far more commercial in character than either the British Association or the Institute of Electrical Engineers. Its delegates are actively engaged in electrical industry, the Papers read are very practical in character, and the resulting discussions straightforward and devoid of abstract theory. If busy men can find time to come together in a country of such extent as America, it is strange we have not yet practically

Digitized by Google

ASPINALL'S ENAMEL

COPY OF LETTER JUST RECEIVED AT NEW CROSS.

A Leading and Well-known Electrician writes:—

"HAVING used your **ENAMEL** considerably for various purposes, I find that it has **GOOD INSULATING PROPERTIES FOR ELECTRICAL WORK**, answering the purpose better than the usual Insulating Compounds in use, *which do not give such an appearance or finish as your* **ENAMEL.**"

Sold everywhere, in Tins; or Post Free, 7d., 1s. 6d., and 3s.; for Baths, 9d., 1s. 9d., and 3s. 6d. from

Works: LONDON, S.E. REJECT WORTHLESS IMITATIONS.

AS AN INSULATOR.

THE GENERAL ELECTRIC CO., Ltd.

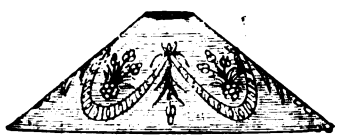
(G. BINSWANGER, *Managing Director*)

(OF LONDON AND MANCHESTER)

TELEGRAMS "ELECTRICITY." **71, Queen Victoria Street, LONDON, E.C.** [TELEPHONE No. 1887.

MANUFACTURERS AND SUPPLIERS OF ALL ELECTRIC LIGHT FITTINGS AND MATERIAL.

1,000 FANCY ELECTRIC SHADES.



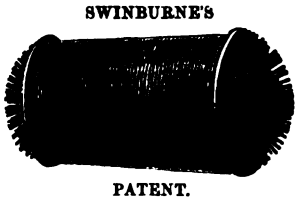
6d. EACH.

TO CLEAR STOCK ODD PATTERNS.

WE GUARANTEE THIS TRANSFORMER TO HAVE A HIGHER EFFICIENCY THAN ANY CLOSED-CIRCUIT TRANSFORMER in the Market.

NO HEAT. PERFECT INSULATION.

SWINBURNE'S



PATENT.

THE "HEDGEHOG" TRANSFORMER.

PRICES include Terminals, Base, &c. Fireproof Cases Extra.

Lamps (30-w.)	H.-P.	Price. £. s. d.	Lamps.	H.-P.	Price. £. s. d.
*25	1	5 10 0	300	12	30 0 0
50	2	8 18 0	400	16	35 0 0
100	4	12 15 0	500	20	40 0 0
150	6	17 17 0	750	30	55 0 0
200	8	20 0 0	1000	40	85 0 0
250	10	24 0 0			

* We do not recommend this Size.

ANY SIZE TO ORDER.

SWINBURNE & CO.

ALTERNATING and CONTINUOUS CURRENT WATT-METERS, MOTORS, INSTRUMENTS.

PRIVATE HOUSE INSTALLATIONS.

IRON TESTED FOR THE TRADE.

BROOM HALL WORKS, TEDDINGTON, ENGLAND.

F. WIGGINS & SONS,

Telephone No. 2248.

10, Tower Hill, E., and 102, Minories, London, E.C.

Manufacturers of MICA GOODS for PHILOSOPHICAL and ALL PURPOSES.

CONTRACTORS TO HER MAJESTY'S GOVERNMENT.

MICA

ELECTRIC TRAM-CARS.

55,000 MILES ALREADY RUN.

Daily Average 300 Miles

(The Greatest Number of Miles ever run in this Country by ACCUMULATOR CARS),

Running on the BARKING ROAD, E.,

FOR THE

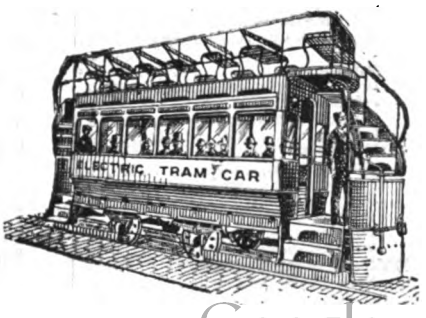
NORTH METROPOLITAN TRAMWAYS CO., LIMITED.

Everyone should see these Cars. Certain to supplant horse and every other form of traction.

Full particulars from the SECRETARY,

ELECTRIC TRACTION CO., Ltd.,

NEW BROAD STREET HOUSE, LONDON, E.C.



Digitized by Google

"THE ELECTRICIAN" INDEX TO ADVERTISERS.

Advertisers in "The Electrician" have their names inserted under the following headings in this Index FREE OF CHARGE.

ACCUMULATORS. PAGE.
Foreign and Colonial Electrical Power Storage Co., Ltd. 7
ACIDS.—Berk (F. W.) and Co. 23
ALTERNATORS.
Brush Electrical Eng. Co. (Ltd.). 21
Electrical Engineering Corpn. .. 486
Johnson and Phillips 1
Parsons (C. A.) & Co..... 11
AMMETERS.
Acme Electric Works ..... —
Goolden (W. T.) and Co..... 11
Nalder Bros. and Co. ..... —
Sharp and Kent..... 4
ANTI-FOULING COMPOSITIONS.—Kirkaldy (J.) and Son. 7
ARC LAMP BLOCKS.
Joyner (Chas.) and Co. ..... —
ASBESTOS.
Bell's Asbestos Company.....26, 27
United Asbestos Company (Ltd.) —
ASBESTOLINE.
Bell's Asbestos Company 26, 27
AUCTIONEERS AND VALUERS (Mechanical).
Wheatley Kirk, Price and Goulty 8
B.A. SCREW THREAD.
Lehmann (Th.) 19
BATTERIES.
Fowler, Lancaster and Co. (Ltd.) 3
India Rubber & Gutta Percha Co. 16, 20
Johnson and Phillips 1
Laing, Wharton and Down 9, 19
Latimer Clark, Muirhead & Co. 1
BATTERY JARS.
Joseph Bourne and Son 19
Cannington, Shaw and Co..... 2
Price, Sons and Co. ..... —
Stiff (J.) and Sons ..... —
BELTING.
Balderston and Co. 21
Moseley (D.) and Sons..... 8
Thompson (N. G.) 22
Willcox (W. H.) and Co..... 20
CABLE COMPANIES.
African Direct Telegraph Co. .. 28
Anglo-American Telegraph Co. 31
Brazilian Submarine Tel. Co. .. 29
Direct United States Co..... 31
Eastern Telegraph Co..... 32
Eastern Extension Telegraph Co. 32
Eastern & South African Tel. Co. 28
Indo-European Co. 30
West African Telegraph Co..... 28
Western and Brazilian Tel. Co... 29
CABLE SUPPLIES.
Latimer Clark, Muirhead & Co... 1
Elliott Brothers 21
Felten and Guilleaume 1
Fowler-Waring Cables Co. (Ltd.) 8
W. T. Glover and Co. 19
W. T. Henley's Teleg. Works Co. 1
India Rubber & Gutta Percha Co. 16, 20
Johnson (R.) and Nephew 2
Johnson and Phillips 1
Pirelli and Co. ..... —
Telegraph Manufacturing Co. .. —
M. Theiler and Sons 3
CARBONS.
Brush Electrical Eng. Co. (Ltd.).. 21
Chamberlain (H. and F.) 22
General Electric Co. 17
India Rubber & Gutta Percha Co. 16, 20
Johnson and Phillips 1
Laing, Wharton and Down 9, 19
Thompson (N. G.) (Carré) 22
Woodhouse & Rawson United, Ltd. —
CASINGS.
Acme Electric Works ..... —
Elliott, Samuel ..... —
Garrard (Robert) and Co. 20
McGaw and Co. 23
CONDUITS.—Johnson & Phillips 1
Fowler Waring Cables Co. 8
CUT-OUTS.
Acme Electric Works ..... —
Dorman and Smith 19
General Electric Co. 17
Laurence, Paris and Scott (Ltd). 19
Wood (W.) and Co. ..... —
Woodhouse & Rawson United, Ltd. —
DISINFECTANTS.—Sanitas Co. 20
DYNAMO MANUFACTURERS.
Allen and Co. 13
British Electrical Eng. Co. (Ltd.).. 21
Latimer Clark, Muirhead & Co.. 1
Crompton and Co. (Limited).... 16
Cuttriss and Co. 6
Edison & Swan United Elec. Lt. Co. 5
Electrical Engineering Corpn. .. 486
Goolden (W. T.) and Co. 11
Gülcher Electric Lt. & Power Co. 23
W. T. Henley's Teleg. Works Co. 1
Holmes (J. H.) and Co. 4
M. Immisch..... —
India Rubber & Gutta Percha Co. 16, 20
Johnson and Phillips 1
Laing, Wharton and Down 9, 19
Laurence, Paris and Scott (Ltd.). 19
Oppermann (C.) 19
Parsons (C. A.) & Co..... 11
Paterson and Cooper 19
Sharp and Kent..... 4
Telegraph Manufacturing Co. .. —
Thompson (N. G.)..... 22
Western Electric Co. 13
DYNAMO BRUSHES.
F. H. Royce and Co..... 3
EBONITE & VULCANITE. PAGE.
Harburg India-Rubber Comb Co. —
D. Moseley and Sons 8
EDUCATIONAL.
School of Electrical Engineering —
ELECTRIC BELLS.
Acme Electric Works ..... —
General Electric Co. 17
India Rubber & Gutta Percha Co. 16, 20
Johnson and Phillips 1
King, Mendham and Co. 6
London Electric Wire Co. 19
Julius Sax 19
Sheppard, Allarton & Madeley.. —
Telegraph Manufacturing Co. .. —
Western Electric Co. 13
Woodhouse & Rawson United, Ltd. —
ELECTRIC LIGHT CONTRACTORS.
Bernstein Electric Lamp Co..... 19
Brush Electrical Eng. Co. (Ltd.).. 21
Latimer Clark, Muirhead & Co. 1
Crompton and Co. (Limited).... 16
Drake and Gorham..... 11
Edison & Swan United Elec. Lt. Co. 5
Electrical Engineering Corpn. .. 486
Foreign and Colonial Electrical Power Storage Co., Ltd. 7
Fowler, Lancaster and Co. (Ltd.) 3
Gülcher Elec. Light & Power Co. 23
W. T. Henley's Teleg. Works Co. 1
India Rubber & Gutta Percha Co. 16, 20
Johnson and Phillips 1
King, Mendham and Co. 6
Laing, Wharton and Down (Thomson-Houston) 9, 19
Parsons (C. A.) and Co. 11
Paterson and Cooper 19
Shippey Bros. (Limited) 6
Woodhouse & Rawson United, Ltd. —
ELECTRIC TRAM CARS.
Electric Traction Co., Ltd. 17
Electrical Engineering Corpn. .. 486
ENGINEERS & CONTRACTORS
Acme Electric Works ..... —
Bernstein Electric Lamp Co..... 19
Blenheim (W.) and Co. 6
Booth, Ellson and Co. 3
Brush Electrical Eng. Co. (Ltd.).. 21
Latimer Clark, Muirhead & Co. 1
Chamberlain and Hookham .... —
Crompton and Co. (Limited).... 16
Drake and Gorham 11
Edison & Swan United Elec. Lt. Co. 5
Electrical Engineering Corpn. .. 486
Fowler, Lancaster and Co. (Ltd.) 3
Foreign and Colonial Electrical Power Storage Co., Ltd. 7
W. T. Henley's Teleg. Works Co. 1
Hulett and Co. (Limited)..... —
India Rubber & Gutta Percha Co. 16, 20
Johnson and Phillips 1
King, Mendham and Co. 6
Laing, Wharton and Down ... 9, 19
Laurence, Paris and Scott (Ltd.). 19
Nalder Bros. and Co. ..... —
Parsons (C. A.) and Co. 11
Paterson and Cooper 19
Julius Sax 19
Sharp and Kent 4
Shippey Bros. (Limited) 6
Starnes (J. S.) and Sons 12
Swinburne and Co. 17
M. Theiler and Sons 3
Thompson (N. G.) 22
Verity (B.) and Sons 22
Westinghouse Electric Company 2
Woodhouse & Rawson United, Ltd. —
ENGINE PACKING.
Bell's Asbestos Company 26, 27
Starnes (J. S.) and Sons 12
Willcox (W. H.) and Co..... 20
United Asbestos Company (Ltd.) —
ENGINES.
Bailey (W. H.) and Co. (Limited) 14
Brush Electrical Engineering Co. 21
Bumsted, F. D. ..... —
Crossley Bros. (Gas) 24
Davey, Paxman and Co. 16
Hindley (E. S.) ..... —
Marshall, Sons and Co..... —
Parsons (C. A.) and Co. 11
Priestman Bros. (Limited) (Oil).. —
Ransomes, Sims and Jefferies .. 23
Richards and Co. ..... —
Robey and Co. 4
Willans and Robinson..... 14
EXPANSION SHEETING AND RINGS.—Bell's Asbestos Co.. 26, 27
United Asbestos Company (Ltd.) —
FITTINGS for ELECTRIC LIGHT
Crompton and Co. (Limited).... 16
Dorman and Smith 19
Electrical Accessories Company 2
Electrical Engineering Corpn. .. 486
Evered and Co. (Limited) ..... —
General Electric Co. 17
Gülcher Elec. Light & Power Co. 23
Hulett and Co. ..... —
Johnson and Phillips 1
Laing, Wharton and Down 9, 19
Ross, Courtney and Co. 6
Telegraph Manufacturing Co. .. —
Verity (B.) and Sons 22
Western Electric Co. 13
Wolverhampton Electrical Co... 23
Wood (W.) and Co. ..... —
Woodhouse & Rawson United, Ltd. —
FIBRE.—Moseley (D.) and Sons .. 8
FUSES.
Electrical Engineering Corpn. .. 486
Fowler, Lancaster and Co. (Ltd.) 3
GALVANOMETERS.
Nalder Bros. and Co. ..... —
GLASSWARE.
Acme Electric Works ..... —
GAS LIGHTERS (ELECTRIC).
General Electric Co. 17
King, Mendham and Co. 6
Woodhouse & Rawson United Ltd —
GLOBES & SHADES.
Dorman and Smith 19
Electrical Accessories Company 2
Fowler, Lancaster & Co. (Ltd.) .. 3
General Electric Company..... 17
Hulett and Co. (Limited) ..... —
INDIA RUBBER.
Moseley (D.) and Sons..... 8
Pirelli and Co. ..... —
INFLUENCE MACHINES.
King, Mendham and Co. 6
INSTRUMENTS.
Acme Electric Works ..... —
Latimer Clark, Muirhead & Co. 1
Crompton and Co. (Limited).... 16
Elliott Brothers 21
General Electric Co. 17
India Rubber & Gutta Percha Co. 16, 20
Johnson and Phillips 1
King, Mendham and Co. 6
Nalder Bros. and Co. ..... —
Paterson and Cooper..... 19
Sharp and Kent 4
Swinburne and Co. 17
Telegraph Manufacturing Co. .. —
M. Theiler and Sons 3
Woodhouse & Rawson United, Ltd. —
INSULATION.
Aspinall's Enamel 17
Johnson and Phillips 1
INSULATORS.
Joseph Bourne and Son 19
Latimer Clark, Muirhead & Co. 1
Gerhardt (C. F.)..... 13
W. T. Henley's Teleg. Works Co. 1
India Rubber & Gutta Percha Co. 16, 20
Johnson and Phillips 1
Price, Sons and Co. ..... —
Stiff (J.) and Sons ..... —
Telegraph Manufacturing Co. .. —
IRON ROOFS & BUILDINGS.
Fredk. Braby and Co. (Ltd.) 25
Francis Morton & Co. 12
IVORY LABELS.
Endolithic Ivory Co..... ... —
LAMPS.
Bernstein Elec. Lamp Co. (Inc.).. 19
Brush Electrical Engineering Co. (Ltd.) (Arc and Incandescent). 21
Consolidated Telephone Construction & Maintenance Co, Ltd 10
Crompton and Co. (Limited).... 16
Dorman and Smith 19
Edison & Swan United Electric Light Co. (Incandescent) 5
Electrical Engineering Corpn. .. 486
Fowler, Lancaster and Co. (Ltd.) 3
Gülcher Electric Lt. & Power Co. 23
Holmes (J. H.) and Co..... 4
Johnson and Phillips (Arc) 1
Laing, Wharton & Down (Edison & Swan) 9, 19
Robertson (C. J.) 19
Sunbeam Lamp Co. 10
Western Electric Co. (Arc)..... 13
Woodhouse & Rawson United, Ltd. —
LIGHTNING CONDUCTORS.
Johnson and Phillips 1
Julius Sax 19
LUBRICANT.
Bell's Asbestos Company 26, 27
Willcox (W. H.) and Co..... 20
MANUFACTURING ELECTRICIANS.
Acme Electric Works ..... —
Latimer Clark, Muirhead & Co.. 1
Dorman and Smith 19
Drake and Gorham 11
Electrical Engineering Corpn. .. 486
Elliott Brothers..... 21
General Electric Co. 17
W. T. Henley's Teleg. Works Co. 1
India Rubber & Gutta Percha Co. 16, 20
Johnson and Phillips 1
King, Mendham and Co..... 6
Nalder Bros. and Co. ..... —
Parsons (C. A.) and Co. 11
Paterson and Cooper..... 19
Ross, Courtney and Co. 6
Julius Sax 19
Telegraph Manufacturing Co. .. —
M. Theiler and Sons 3
Westinghouse Electric Company 2
Woodhouse & Rawson United, Ltd. —
MOTORS (ELECTRIC).
Brush Electrical Eng. Co. (Ltd.).. 21
Cuttriss and Co. 6
Electrical Engineering Corpn. .. 486
Goolden (W. T.) and Co..... 11
Gülcher Electric Lt. & Power Co. 23
Holmes (J. H.) and Co..... 4
M. Immisch..... —
Laurence, Paris and Scott (Ltd.) 19
Parsons (C. A.) and Co. 11
Shippey Brothers (Ltd.) 6
METERS (ELECTRICITY). PAGE.
Chamberlain and Hookham 7
MICA.—F. Wiggins and Sons 17
NON-CONDUCTING COMPOSITION.
Bell's Asbestos Company 26, 27
United Asbestos Co..... —
PAINT, &c.
Indestructible Paint Co..... 20
PATENT AGENTS—Berg (E.). 3
Chapman (J. C.) 20
PIPES (STONEWARE).
Scott and Co ..... —
PLATINA SCRAPS.
Jamieson (W. & J.) 2
PRINTING AND ENGRAVING.
Waterlow and Sons (Limited) .. 13
POROUS CELLS.
Joseph Bourne and Sons 19
Price, Sons and Co. .. .. —
Stiff and Sons ..... —
PULLEYS.—Richards and Co. .. —
SECOHMMETER.
Nalder Bros. and Co. ..... —
SHEET IRON.
Baldwin (E. P. and W.) 19
SOCKETS.—General Electric Co. . 17
SPEED INDICATORS.
Bailey (W. H.) and Co. (Limited) 14
Blamires (T. and H.)..... 3
SUPPLIES FOR CABLE SHIPS.
Lack (F.) and Sons 30
Starnes (J. S.) and Sons 12
Duncan Wallet and Co. 30
SWITCHES.
Acme Electric Works ..... —
Crompton and Co. (Limited).... 16
Dorman and Smith 19
Drake and Gorham 11
Edison & Swan United Elec. Lt. Co. 5
Fowler, Lancaster and Co. (Ltd.) 3
General Electric Co. 17
Holmes (J. H.) and Co..... 4
Sharp and Kent 4
Thompson (N. G.)..... 22
Verity (B.) and Sons..... 22
Wolverhampton Electrical Co... 23
Wood (W.) and Co. ..... —
Woodhouse & Rawson United, Ltd. —
TELEGRAPH ENGINEERS.
Acme Electric Works ..... —
Latimer Clark, Muirhead & Co.. 1
Elliott Bros. 21
W. T. Henley's Teleg. Works Co. 1
India Rubber & Gutta Percha Co. 16, 20
Johnson and Phillips 1
Telegraph Manufacturing Co. .. —
Theiler (M.) and Sons 3
TELEGRAPH PAPERS.
Waterlow and Sons (Limited) .. 13
TELEPHONES.
Blenheim (W.) and Co. 6
Consolidated Telephone Construction & Maintenance Co, Ltd. 10
Stanhope Company ..... —
Theiler (M.) and Sons 3
TOOLS.—Penn and Co. 22
TRANSFORMERS.
Brush Electrical Engineering Co. 21
Electrical Engineering Corpn. .. 486
Gülcher Elec. Light & Power Co. 23
Johnson and Phillips 1
Sharp and Kent 4
Swinburne and Co. 17
TUBES, &c.—Spencer (John) .... —
TYPE-WRITING.
Richardson (W. J.) and Co..... —
VALVES.—Mosses and Mitchell .. 485
VENTILATING ENGINEERS.
Blackman Ventilating Company. 3
VOLTMETERS.
Acme Electric Works ..... —
Drake and Gorham 11
Edison & Swan United Electric Light Co. 5
Goolden (W. T.) and Co..... 11
Nalder Bros. and Co. ..... —
Sharp and Kent..... 4
VULCANISED FIBRE.
Mosses and Mitchell..... 485
VULCANITE.
Harburg India-Rubber Comb Co. —
Moseley (D.) and Sons 8
WATCHES (NON-MAGNETIC).
Bedford (H. W.)..... 6
WIRE (Covered or Uncovered).
Latimer Clark, Muirhead & Co.. 1
Felten and Guilleaume 1
Fowler-Waring Cables Co., Ltd. 8
W. T. Glover and Co. 19
W. T. Henley's Teleg. Works Co. 1
Johnson (R.) and Nephew 2
Johnson and Phillips 1
Laing, Wharton and Down 9, 19
London Electric Wire Co..... 19
Phillips Bros. 19
Phosphor Bronze Company 484
Telegraph Manufacturing Co. .. —
Western Electric Co. 13
WIRE-ROPES.
Barraclough and Co. 2
Johnson and Phillips 1
WIRE-TESTING APPARATUS.
Woodhouse & Rawson United, Ltd. —
WOOD (*see* CASINGS).

Digitized by Google

E. P. & W. BALDWIN,

Works:—WILDEN, near STOURPORT.

MANUFACTURERS OF

PURE CHARCOAL SHEET IRON, SUITABLE FOR ELECTRICAL PURPOSES.

London Agents: BROOKER, DORE & CO., Corbet Court, LONDON, E.C.

INCANDESCENT LAMPS

FOR SHIPPING AND EXPORT.

LAMPS OF ALL VOLTAGES & CANDLE-POWERS
FITTED WITH ANY FITTINGS.

The Quality and Durability of these Lamps can be attested by Users and Customers during the past Three Years.

Prices.—For Lamps of between 5 and 25 c.-p., any Volts or Efficiency, including Fittings of any of the usual makes, Cases, Packing and **Free Delivery** in the United Kingdom and many other countries, from **1s. 11d.** to **2s. 6d.** each, according to quantity.

For further particulars and Samples address—

C. J. ROBERTSON,
100, ALDERSGATE STREET, LONDON, E.C.

BRITISH ASSOCIATION STANDARD SCREW THREAD

TAPS, SCREW PLATES, DIES, GAUGES,
&c. ($\frac{1}{4}$ to $\frac{1}{52}$ in.),

SUPPLIED BY **TH. LEHMANN,** Original Maker to G.P.O.

38, HAMPSHIRE STREET, TORRIANO AVENUE, LONDON, N.W.

OPPERMANN'S EXCELSIOR DYNAMOS,

OF HIGHEST POSSIBLE EFFICIENCY,

Are now made in Sizes to suit small Gas and Steam Engines from 5 Lights and upwards. Prices from **£6.**

The PLATING and DEPOSITING DYNAMOS
Have met with much Approval for nearly Ten Years, and are
More Used in London than any other Manufacturer's.

Send for Prices and Testimonials to

CARL OPPERMANN, 41, SIGDON ROAD, HACKNEY, LONDON, N.E.

THE BERNSTEIN ELECTRIC LAMP CO., LTD

2, MARLBOROUGH MANSIONS
VICTORIA STREET, WESTMINSTER, S.W.

OWNERS OF THE

BERNSTEIN SYSTEM OF ELECTRIC LIGHTING.

The lamps of this Company are of low resistance, and entirely free from the claims of other companies.

ADDRESSES.

LAING, WHARTON, & DOWN, 82a, NEW BOND-STREET, LONDON, W., Electric Light Engineers & Contractors. Sole Operators for England of the Thomson-Houston system of Arc Lighting. Special Agents for the Edison-Swan Co.'s Incandescent Lamps and Apparatus. Manufacturers and Suppliers of every requisite for Arc or Incandescent Lighting, Dynamos, Lamps, Switches, Electroliers, Brackets, &c. Specialities in Primary Batteries for Electric Lighting, Venetian Shades and Glass, Carbons, &c. Temporary lighting on any scale at short notice. Estimates free. Telephone No. 3602.

JULIUS SAX, Electrical Engineer and Electric Light CONTRACTOR, RIDGMOUNT STREET, STORE STREET, LONDON, W.C.

Established 1855.

Specialities—Electric Bells, Burglar Alarms, Fire Alarms, Watchmen's Clocks and Fire Indicators combined, Water Gauges, Billiard Markers, Electric Vanes, Lightning Conductors, Speaking Tubes, Gas Lighters, Electrical Testing and Telegraph Instruments, Electrical Torpedo Apparatus.

Automatic Call Bells for Fire Stations, &c., fixed at all Stations under the control of the Metropolitan Board of Works.

Call Calls for Police Stations, Prisons, &c., as devised for and adopted by H.M. Home Office. Contractor to H.M. Post Office and War Office.

Electric Lighting—Domestic and Public. Estimates Free on Application. Eight Prize Medals awarded.

Telephone No. 3848. Telegraphic Address: "*Sax—London.*"

WALTER T. GLOVER & CO., Electric Wire and Cable Makers, SALFORD, MANCHESTER. Works: Bridgewater-street, Broughton-road, Salford; Salford Electric Wire Works, Salford; Springfield-lane Cable Works, Salford. Established 1868. London Address, 10, Hatton-garden, E.C.; Telegram, "Phonoscope," London; Telephone No. 6691. Manchester—Telegram, "Walter Glover," Salford; Telephone No. 1187.

Specialities—Glover's patent covered Gutta Percha Wire for Leading-in, Tunnel, and Underground Work. Specially covered Iron and Copper Wire for Aerial Lines. Fancy covered single and Double Copper Wire (Paraffined) for Telephonic and Bell purposes. All classes of Silk and Cotton covered Wires for Instruments and Dynamo Machines, Glover's Patent Electric Light Leads and Cables for the various systems.

All descriptions of Covered Wire and Cables for Telegraphic, Telephonic, and Electrical Work, as supplied to the Post Office and the principal Railways, Electric Light, and Telephone Companies.

ADDRESSES.

LAURENCE, PARIS and SCOTT, Limited, Electrical ENGINEERS and CONTRACTORS, GOTHIC WORKS, KING-STREET, NORWICH. Dynamos, Motors, Automatic Cut-Outs, Back Current Cut-Outs, Excess Alarms, Multiple Switches, and Switch Boards. Complete Electric Lighting Plants. Central Station Plants. Estimates on Application.

PHILLIPS BROS., Electrical Wire Manufacturers, The Lea Telegraph Works, HACKNEY WICK, LONDON, E., late of Macintosh-lane, Homerton. Established 1870. Telephone No. 5422.

Specialities—Gutta Percha, India Rubber, Compound, Cotton, Silk, Flexible Cords, Telephone Wire, &c., &c. Multiple and other Wires. Special Wires for Dynamo Machines. Electric Light Leads, &c. Patent Non-Inflammable Insulation for Incandescent and Arc Lighting and Dynamo Machines.

THE LONDON ELECTRIC WIRE COMPANY, ANCHOR WORKS, PLAYHOUSE-YARD, GOLDEN-LANE, LONDON, E.C. (Late of Wenlock-buildings, Ironmonger-row, E.C.)

Specialities—Covered Wires of all descriptions for Electrical Instruments, Dynamo Machines, Bell and House Work, &c. Fancy Paraffined Wires specially prepared for Telephone and other indoor connections.

JOSEPH BOURNE and SON. Works: DENBY POTTERY, near DERBY. London: 6, ST. PANCRAS STATION. Manufacturers of the well-known Stoneware Telegraphic Insulators and Battery Jars. Brown Stoneware. White Stoneware. Brown Porcelain. Porous Cells. Economy, strength, durability, and perfect insulation combined. Prize Medal, Paris Electrical Exhibition.

Makers of Mr. Slater Lewis's Patent Self-Binding Insulator.

J. G. STATTER and CO., Limited, Engineers, ALLIANCE ENGINEERING WORKS, WEST DRAYTON. London Offices, Prince's Mansion, 68, Victoria-street, Westminster, S.W. Dynamos and Motors for all Purposes. Perfect Constant-Current System of Arc Lighting. Estimates free. Write for Lists.

PATERSON and COOPER, Electric Light and Power and Telephone Engineers. EUROPEAN WORKS, POWNALL ROAD, DALSTON (Near Haggerston Station). Contractors to H.M. Government, Leeds Corporation, &c.

Specialities—Phœnix Dynamos, Pilsen, Phœnix, and Clark-Bowman and J. F. Arc Lamps, Cardew's Voltmeter, Paterson's Electromagnet Am- and Voltmeter, Ayrton-Perry Am- and Voltmeters, Wallace Diamond Carbons, Switches, Safety Junctions, and Fittings for Arc and Incandescent Lighting. (Removed from 76, Little Britain, since Nov. 16, 1885).

Digitized by Google

THE
INDIA RUBBER, GUTTA PERCHA, & TELEGRAPH WORKS
COMPANY, LIMITED.

Offices: 106, CANNON STREET, LONDON, E.C.

MANUFACTURERS OF
DYNAMO MACHINES,
INSULATED ELECTRIC LIGHT WIRES AND CABLES,
Lamp Fittings, Switches and Testing Apparatus, Volt and Ampere Meters.
CONTRACTORS FOR THE SUPPLY AND FITTING UP OF
ELECTRIC LIGHT APPARATUS
OF EVERY DESCRIPTION.
INSTALLATIONS FOR CENTRAL STATIONS, SHIPS, HOUSES, OR FACTORIES.
ESTIMATES ON APPLICATION.
Works: SILVERTOWN, LONDON, E.
[See detailed advertisement facing "Notes."

W. H. WILLCOX & CO.,
ENGINEERS' STORES FOR ELECTRIC LIGHT COMPANIES.
36, SOUTHWARK STREET, LONDON, S.E.
Works: EWER STREET. Telephone No. 4749. Telegraphic Address: WILLCOX, SOUTHWARK STREET, LONDON.

Stores:
ENGINE PACKING,
LEATHER BELTING,
LUBRICATING OILS
— OF —
EVERY DESCRIPTION,
CYLINDER OIL,
DYNAMO OIL.

Stores:
SPONGE CLOTHS & COTTON WASTE,
SICHT FEED LUBRICATORS,
STEAM FITTINGS,
COTTON, HAIR, AND INDIA-RUBBER BELTING.

MAHOGANY, HARDWOODS AND TIMBER.
Telegraphic Address: "ACAJOU LONDON.
ROBERT GARRARD & CO.,
206, BETHNAL GREEN ROAD, LONDON, E.
THOROUGHLY SEASONED
MAHOGANY, TEAK, WALNUT, OAK, &c., &c. DRY PINE, PITCH PINE and DE S
CABLE CASINGS AND COVERS IN ALL WOODS AND DESIGNS.
Seasoned Woods Cut to Sizes for Telephone Boxes, Electric Apparatus, &c.
LOGS.—MAHOGANY, TEAK, WALNUT AND OTHER LOG TIMBER, IN TIERS OR SINGLE LOGS. SPECIFICATIONS ON APPLICATION.

TRADE "SANITAS" MARK.
DISINFECTANTS
(FLUIDS, POWDER, SOAPS),
NON-POISONOUS, PLEASANT AND BEST.
Used by more than 1,000 Boards of Health and Hospitals.
Gold Medals, Calcutta 1883-4, Paris 1885, Antwerp 1886.
For use at the Home and Foreign Stations of Telegraph Companies and on Board Ship.
"Valuable Antiseptic and Disinfectant.—*Times*."
"Safe, pleasant, and useful."—*Lancet*.
The "Sanitas" Company, Limited,
LETCHFORD'S BUILDINGS, BETHNAL GREEN, LONDON.

Digitized by Google

recognised the possibility and importance of a similar association here. This might be done by the establishment of an Electrical Engineering Section of the British Association. The formation of an Electrical Section of the London Chamber of Commerce is certainly a move in the right direction, although such a body is too local to be altogether satisfactory.

The commercial value of the social element of such an Association consists in its tendency to promote harmony among rivals, and to lead, wherever possible, to the consolidation of interests. The committee appointed to inquire into the possibility of harmonising insurance and electric lighting interests in America has led to important results in connection with mutual insurance, and the proposed establishment of a standing committee, working in harmony with the insurance people, to draw up a uniform code of rules, and to constitute a body to whom disputed questions might be referred. One of the committees was appointed to consider the question of underground conduits. The great importance of this subject is such as to merit similar recognition from our own electrical societies. The committee charged with the duty of memorialising Congress with the view of bringing about free trade in copper seem likely to succeed in their efforts, and an instance is thus given of the political advantages arising from such an Association.

The report of the committee on the standardisation of potentials illustrates a tendency peculiarly American. In England manufacturers are still too willing to consider the wants of small isolated installations, and to make dynamos having outputs in volts and amperes specified by the buyers. In America, where central stations are more common, the tendency for a long time has been to produce only certain types of machines, converters, lamps, &c. Great advantages result to both buyer and seller from this process of standardisation. For instance, if a firm only makes dynamos of certain fixed sizes, the manufacture is rendered cheaper and the parts of the machine are replaceable, and can be renewed at a cheap rate. As electrical business increases it can scarcely be doubted that it will become necessary to manufacture machines and lamps to work at a few standard potentials; and English electrical industry would be advanced by promoting a conference of manufacturing firms with the object of coming to an agreement on this matter. The Special Committee on Potentials have now reported that the two leading American electric railway companies have agreed to work with a uniform potential of 500 volts, and that in all probability this potential will become the standard all over the States for street railway companies. The fact that the committee, while recommending electric light companies to add to their business by furnishing motive power to street railroads, point out the fallacy of the idea that the same machines may be advantageously used for both purposes, lends fresh evidence in favour of the standardisation of potentials, since the reserve power for one service can be easiest utilised for the other when there is a simple relation between the potentials used for the two systems.

The fact that electrical industry is now in a state in which it is more promoted by minute attention to details, and by the economisation of methods, than by the discovery of new principles, was brought out in several of the Papers. The days of fancy profits are quite gone. Competition has rendered the economical details of machine construction of far more importance than the type of design. The Papers on carbon tests and waste in arc light carbons brought out the importance of choosing right material, and of being as saving as possible in its use. The Paper of Mr. CARPENTER SMITH on a universal system of central station accounts contains many suggestions of practical value. Some of these are unnecessary for English firms, who, as a rule, attend to the small items of expense more carefully than is the case across the Atlantic; but the need of detailed accounts should be readily admitted now that common-sense business principles rule electrical industry. The advantage of keeping such accounts is twofold. By comparison of the amount of each item of expense from month to month a firm can detect any "leak in the business" and remedy it. Much of the matter contained in such accounts could, moreover, be divulged, without personal loss, at meetings of the National Association; so that it would be possible for each firm, by comparing its accounts with those of others, to discover where unnecessary expense was incurred.

Two important Papers by Prof. HOUSTON and Mr. LOCKWOOD dealt with the pressing subject of safety. The PRESIDENT, while condemning the present sensational agitation in America in connection with this matter, ventured the statement that the public had a kind of right to expect that the number of serious accidents accompanying the introduction of electrical industries should be less than those incurred in the introduction of steam and gas, since safety devices should keep pace with general development. Prof. HOUSTON, while fully admitting the danger when insufficient precautions were adopted, stated that the danger depended not on low or high tension, or on using direct or alternating currents, but on the methods of insulation employed, and the use of safety devices. He laid special stress on the fact that good methods of insulation and careful work meant good service; and urged the great importance of the adoption of more numerous safety devices. The Paper of Mr. LOCKWOOD showing how to make arc circuits safe, is naturally not of so much interest here as in America. The methods of continuous test proposed are, however, of great value, and are suggestive of modifications for other circuits. The important Paper of Mr. SPRAGUE has already been placed before our readers. The scope of the matter discussed by the Association was further widened by the presentation of valuable Papers on the economical generation of steam for electric light stations, on the steam engine, and on the construction of central stations. The inclusion of matter of a purely engineering nature is a good feature of an electrical association which might with advantage be reproduced in our own electrical societies.

OBITUARY.

WILLIAM HENRY SNELL.

It was our sad duty last week to announce the death of the Editor of *The Electrician*. Born on November 6, 1858, William Henry Snell showed in early life a natural aptitude for his future career. His early work in his native town of Tiverton was unconsciously the foundation of the success which he afterwards attained in the electrical profession. He received at Blundell's School the foundation of his general education. Not enjoying at any time robust health, he was in a measure thrown on himself, and developed a liking for physical study and research. Before he was 20 years of age he qualified as a science teacher at Kensington, and commenced teaching chemistry in Tiverton. He was also connected with the Literary Society of the town. In writing essays for this, and in contributing to the *Tiverton Gazette*, he no doubt cultivated the incisive style of writing peculiar to him. About this time he commenced original research in electrical matters, making most of his instruments himself. These experiments were continued for about three years, finally culminating in 1882 in inventions in connection with the microphone and telephone. He then came to London, but not being successful in exploiting these inventions, he turned his attention to the general study of electric lighting and the transmission of power, and entered the Hanover-

Digitized by Google

square School of Electrical Engineering. He soon took the foremost place amongst the students, winning the confidence of the instructors, who entrusted him with special original work. On leaving this institution in 1883 he took the highest certificates.

His first entrance to practical work was made with the Cunard Company, to whom he was the first and only chief electrician. Here his extensive knowledge and originality were at once apparent. He reorganised the system of ship lighting, saving both money and time and increasing the efficiency of the service. In 1884 he left the Cunard employ and returned to Tiverton. During the next six months he studied alternating-current distribution, and when he returned to London in June, 1885, read a Paper entitled "The Calculation of Mains for the Distribution of Electricity," before the Society of Telegraph Engineers and Electricians, gaining the Paris premium. This Paper at once stamped him as a man of more than ordinary ability. In the same year he assisted Prof. G. Forbes in some important calculations in connection with the distribution of electric light over large areas. These calculations were subsequently embodied in Prof. G. Forbes' well known Cantor Lectures of that year, and were made use of in evidence before a Select Committee of the House of Lords in May, 1886. About this time he invented, in conjunction with Messrs. Sharp and Kent, a virtual resistance for alternating currents. His name also figured in connection with the Kapp and Snell transformer.

In 1886 he joined the staff of *The Electrician* as assistant editor, after being for a few months a member of the staff of *Industries*. In 1887 he was appointed editor-in-chief of *The Electrician*, and here he found a congenial sphere of action for his great energy and abilities, the columns of this journal testifying how well he fulfilled the functions of this onerous and responsible position. Far from strong at any time, the stress of work soon began to tell on him, and early in the summer of last year signs of physical weakness began to show themselves. Nevertheless, he bravely stuck to his post, in spite of the urgent entreaties of all his friends, until the autumn. He then, acting under medical advice, sought rest and change at Matlock. Here he still further declined in strength, and it was then decided to try what the air and loving care of home would effect. It was, however, all to no purpose. He died on Wednesday, the 5th instant, passing quietly away, and was buried on Monday, the 10th, in the family vault at Tiverton.

Although forming but a small portion of his writings, the following signed contributions to *The Electrician* may be mentioned:—"On Resistance Coils for Large Currents," "Multiple Main Systems," "Ship Lighting by Electricity," "Alternating and Induced Electromotive Forces."

He was a member of the Institution of Electrical Engineers, and of the Physical Society, and he served on the Committee of the Electrical Trades Section of the London Chamber of Commerce.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

SOME POINTS IN DYNAMO AND MOTOR DESIGN.*

BY W. B. ESSON, MEMBER.

(Continued from page 452.)

8. The Load to be Carried by Armatures.

Assuming that a machine is properly designed, a position can be found for the brushes where the sparking is *nil*. If, on the other hand, the machine is badly designed, or if the current carried by the armature is too great, a sparkless collection will be found impossible from the excessive distortion produced by the armature field. There is for every machine a certain limiting number of ampere-turns which the armature can carry beyond which we cannot go without effecting some radical alteration in the design.

Now it is manifestly of the very greatest importance to know to what extent an armature can be loaded for a given field. It will be understood that the cross induction—that is, the lines of force which can be induced by the armature winding—depends upon the number of ampere-turns on the armature, and upon the magnetic resistances of the various parts which make up the cross circuit. Undoubtedly the induction follows the same law for the cross as for the forward circuit, though it is difficult to determine with accuracy either its magnitude or direction. But we know that by far the largest portion of the resistance is encountered in the air-gap, and that increasing the length of the gap diminishes almost in inverse ratio the cross induction. We know also that the cross induction depends on the width of the air-gap, for the greater the cross-section of the gap, the greater the cross induction for a given cross-section of armature core and a given magnetising force. It depends also, but to a less extent, on the induction in the core.

The forward induction we can give to a machine may be considered as proportional to the cross-section of the armature core; for if the magnets are large enough, with sufficient magnetising force, we can always in normal types get an induction of 16,000 to 17,000 C.-G.-S. per square centimetre.

Now the distortion of the field depends upon the ratio of the cross to the forward induction. In actual machines we have not, of course, two sets of lines crossing each other, but the tendency to produce a cross induction is manifested in a distortion produced in the forward lines. It is to prevent the sparking which would ensue, due to this distortion, that a lead is given.

The cross induction may be reduced in double-magnet machines by thinning down the magnets as shown in Fig. 3. This illustrates a type of magnet I designed in 1884, which gave first-class results, to the great surprise of many who believed that no good effects could be obtained without massive pole-pieces, irrespective of the configuration of the magnetic circuit otherwise. For the reasons given in Section 3, it is undesirable to reduce the section of single-magnet machines with this object. Another plan for reducing cross induction is in making the air-gap increase from the crown of the poles towards the tips, as was done by Messrs. Paterson and Cooper in the Lumley machines before I joined them, and as is done in some of the Manchester machines for another purpose.

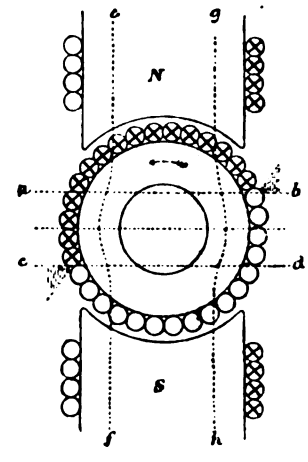


Fig. 19.

As both forward and cross induction are proportional to the length of the armature, we need not consider that dimension here, but simply confine ourselves to the cross-section of the armature and poles as shown by the several drawings. A lead being given to the brushes, it will be observed that the convolutions lying between the two horizontal lines *a b* and *c d*, Fig. 19, directly oppose the forward induction along *e f* and *g h*, since the current flows in them in the opposite direction to the current round the magnets. The lines of force which would be sent in an opposite direction may be called the backward induction. This, *per se*, is of little consequence, as it can be compensated by additional turns on the magnets, but the distortion of the field to which its existence is due is of enormous importance.

It is not my intention to take up time with any calculations respecting the actual number of cross lines which would be induced by the current flowing in the armature, or to try and map out the exact distribution of the field as modified by cross induction. For the present I will be content with the statement—which is, of course, open to criticism—that, roughly, the cross induction is proportional to the ampere-turns on the armature and to the width of the poles, measured parallel to the direction of rotation, and inversely proportional to the length of the air-gap, *i.e.*, the distance between the polar surface and the surface of the armature core. Calling A_2 the ampere-turns on the armature, w the width of the air-gap, and l its length, the tendency to induce cross lines is measured by $\frac{A_2 w}{l}$; and since the forward induction is proportional to the radial depth of the core r for all sizes of machines, the ratio between the above value and r should be similar. In

* Read before the Institution on February 20, 1890.

Digitized by Google

other words, the ampere-turns which can be carried by the armature are proportional to the radial depth of the core and to the length of the air-gap, and inversely as the width of the pole; whence

$$A_2 \propto \frac{r\,l}{w}.$$

For the purpose of showing to what extent some such relation as exhibited obtains in the machines now made, I have given in Table II. the dimensions of several taken at random. In the first

TABLE II.—*Loads carried by Cylinder Armatures.*

Name of Machine.	I. Outside Diam. of Arm. Core.	II. Ampere Turns on the Armature.	III. Radial Depth of the Core.	IV. Angle embraced by each Pole.	V. Length of the Air Gap.	VI. Width of the Pole-Piece.	VII. Co-efficient.
				deg.			
DYNAMOS.							
1. Gramme ...	18·3	6 060	2·65	135	0·85	23·0	61,265
2. Phœnix	22·2	6,500	2·85	115	0·80	24·0	68 421
3. Phœnix	27·0	9,000	3·35	112	0·96	28·5	79 757
4. Crompton ..	18·3	7,560	3·80	135	0·96	23·5	48,700
5. Manchester.	24·1	10 500	5·05	139	0·80	31·0	80 569
6. Phœnix	33·0	13,500	5·10	115	1·10	35·5	85,427
7. Kapp	33·0	13,020	5·30	140	1·25	43·0	84,507
8. Phœnix	35·5	18,000	6·35	122	1·20	40·6	95,905
9. Kapp	36·8	13,875	6·10	140	1·25	48·0	87,344
10. Crompton ..	39·35	26,400	7·94	135	1·95	51·0	86,959
11. Phœnix	43·0	23,000	8·90	115	1·27	44·2	89,940
12. Phœnix	42·6	17,100	7·30	120	1·27	47·0	86,689
MOTORS.							
13. Immisch ...	30·4	9,000	6·40	120 / 130	0·96	3·52	51,562
14. Immisch ...	38·0	15,000	7·60	120 / 130	0·96	43·5	89,432
15. Immisch ...	61·0	27,360	11·40	120 / 130	1·63	70·0	102,840

column after the names of the dynamos comes the outside diameter of the armature core, which does not enter into our expression. Next come the ampere-turns carried, followed by the radial depth in centimetres, with both of which we have to do. In column IV. is given the angle in degrees embraced by each pole, while columns V. and VI. give the length of the air-gap and width of the pole. In column VII. is given a coefficient by which the right-hand side of the equation must be multiplied, in order that for the sign of proportionality we can in each case substitute equality. According to the proposition put forward this coefficient ought to have the same value in all cases. The agreement is marvellous when we remember that in machines of the same size we have to vary the load considerably to suit different outputs, and that in the examples given the saturation may vary considerably. The disturbance due to cross induction bears about the same proportion in all; the similarity in this respect being, in fact, remarkable for machines so dissimilar otherwise. The machines Nos. 7 and 9 have iron wire cores, but Mr. Kapp has kindly given me the equivalent dimension of the radial depth were plates employed instead, and this is what appears in column III. The machine No. 4 is given because it is the one which departs most from my equation. The ampere-turns on the armature are here so few—that is to say, there is so little copper and so much iron—that I at one time suspected it of being the very machine which Mr. Crompton confesses to having designed during Mr. Kapp's absence at Vienna.* In the machine No. 8 the coefficient has been since reduced by narrowing the poles. About the motors Nos. 13, 14, and 15 I shall have something to say presently. In these the edges of the poles are curved along their lengths, hence the two angles in column IV. The coefficient is calculated from the mean width.

Inserting what appears to be the mean value in column VII., we have for the ampere-turns which may be carried by an armature the expression,

$$A_2 = \frac{r\,l\,85{,}000}{w},$$

which may prove very useful until we get something more exact. We have been taught by experience that diminishing the ampere-turns, increasing the radial depth, increasing the air-gap, or diminishing the width of the poles, reduces the distortion and cures its attendant evil of sparking. The equation states the same thing in another way, for it tells us that the ampere-turns may be increased in proportion to the radial depth and to the length of the air-gap, and inversely as the width of the poles. I do not wish for a moment to dogmatise on this subject. It is not pretended that the expression is complete, as there are doubtless many factors upon which the load depends. Amongst these are, obviously, the number of sections of the armature, the shaping of the pole-pieces, and the general configuration of the magnetic circuit. But the equation is at least a guide, and if the coefficient 85,000 is not exceeded, the machine can certainly be made to run without sparking. The expression applies equally to armatures with more than two poles, only in the case of these the ampere-turns given by it must be multiplied by the number of pairs of poles.

When speaking of the radial depth being increased it is of course assumed that there is the same induction per square centimetre in the increased section of the core. Again, increasing the air-gap is not supposed to diminish the induction, as additional magnetising force must be provided to keep it up to its original value. We conclude, then, that if the output of a machine of given carcase dimensions is to be increased—or, in other words, if the ampere-turns on the armature are to be greater—the tendency to increased cross induction must be counteracted by increasing the resistance of the air-gap. Some will doubtless be astonished to hear that greater output necessitates increased magnetic resistance.

Mr. Ravenshaw has a rule to the effect that in order to prevent sparking, in cylinder armatures the ampere-turns must not exceed 35 times the total area of the core in centimetres, or in drum armatures, assuming the same induction per square centimetre, 70 times the area. The rule has been applied to the construction of several types of two and four-pole machines, but it does not seem to me universally applicable, since the number of ampere-turns allowable depends not only on the area but on the relation of the two factors which make up the area.

Practical men must have rules of some kind. Without them their practice could not be continued for a single day. These rules, written or unwritten, are the results of experience which have been aggregated into some kind of applicable shape, but justification for which it would often be difficult to find on purely scientific grounds. We have to make our rules as we go along, engineering intuition and empiricism leading the way, knowledge and scientific accuracy following. We can speak with authority regarding the utility of a formula which we would be ill prepared to justify scientifically. It is because the rule here given has proved useful to me that I venture to suggest its use to others.

TABLE III.—*Loads carried by Drum Armatures.*

	Name of Machine.	Diameter of Armature Core, in cms.	Ampere-Turns on Armature.
	DYNAMOS.		
1	Edison, No. 4	16·0	8,440
2	Edison, No. 5	18·0	10,330
3	Weston, 6 M.	18·75	10,488
4	Weston, 6 W.I.	18·8	11,200
5	Weston, 7 M.	21·8	16,400
6	Edison, No. 10	24·3	13,150
7	Edison, No. 20	24·3	17,260
8	Edison-Hopkinson	24·5	13,200
9	Siemens	29·2	17,600
10	Westminster	39·4	22,000
	MOTORS.		
11	Immisch	14·6	7,600
12	Immisch	17·2	9,000
13	Immisch	24·8	14,700

Regarding drum armatures I have not been able to get such full information; but in Table III. are given the diameters and ampere-turns on the armatures of some well-known machines. There seems to be little agreement, at first sight, between the diameter and the ampere-turns; but if these are plotted as abscissæ and ordinates respectively, it will be found that a straight line can be drawn through the intersection of the axes, giving a very fair mean of all the points save 5 and 7, which are abnormally high. The relation denoted by this line is A_2 = diam. in centimetres × 570. It will be understood, of course, that the induction may be very different in these armatures, as well as the ratio between the external diameter and central opening. If we take the latter as ·4 of the diameter, the ampere-turns are 1,900 times the radial depth of the core, in centimetres.

9. MAGNETISING FORCE REQUIRED TO COMPENSATE THE BACKWARD INDUCTION.

The weakening of the field by the current flowing in armatures wound on the Hefner von Alteneck principle has been studied by Drs. J. and E. Hopkinson; but from the fact that the lead upon which the weakening depends is, in Gramme-wound armatures, much greater and to a large extent indeterminate, it follows that, in designing, some approximate rule must be employed to fit the types of machines in which these are employed. We may estimate the effect of weakening in two ways: first, we may excite the magnets with a constant current, and measure the fall of E.M.F. due to the armature current; or, secondly, we may, by increasing

* *Jour.* Soc. Tel. Engrs., Vol. XV., 1886, p. 546.

Digitized by Google

the magnetising force, keep the E.M.F. up to the same value when a current flows as when the machine is working at no load, measuring the ampere-turns required to effect this compensation. The latter is the proper course to adopt, since, having pre-determined the magnetising force required for the induction in the armature at full load, on the assumption that there are no disturbing reactions, we wish to know what addition is to be made to the force so determined. The weakening of the field is much greater in cylinder than in drum machines, owing to the greater lead required to obtain a sparkless collection; accordingly the magnetising force necessary to compensate the backward induction must be greater for cylinders than for drums. Its actual value depends, necessarily, on several things besides the ampere-turns on the armature, such as the degree of saturation employed, the ratio of armature to field section, the shape of the pole-pieces, and the magnitude of the stray field. The particulars relating to the degree of saturation, the sections, stray field, &c., of the Phœnix machines have already been given, and from actual practice we find that there has to be added to the magnetising force, in order to compensate the backward induction in these machines, ·33 of the ampere-turns on the armature. By the ampere-turns on the armature is meant, as already stated, the product of the number of external conductors and half the total current. This is for a single horse-shoe machine. If there is a divided magnetic circuit constituted by two horse-shoes, with their like poles butting, the number of ampere-turns here given has to be wound on each horse-shoe.

I have met with some very curious rules for determining the compensating turns. These generally take the form of adding to the magnetising force determined for the required induction at full load such additional ampere-turns as will increase the induction about 5 per cent. It is assumed that at full load the E.M.F. will be as desired, the 5 per cent. extra being for compensation. This method is, of course, incorrect, for the magnetising force added should be for a given machine some function of the armature windings. I believe that for most Gramme-wound machines the value of the compensation coefficient here given will hold good. The compensation coefficient for drum machines I have not yet been able to determine.

10. Total Magnetising Force.

To the magnetising force required for a simple magnetic circuit as given in 1, we have to add the force required to compensate the backward induction, as given above. The equation for the magnetising force now becomes for cylinder machines—

$$A_1 = Lf\left(\frac{N}{a}\right) + L_1 \cdot 8\,{}^{v_1}_{a_1} N + L_2 f\left(\frac{v_2 N}{a_2}\right) + L_3 f\left(\frac{v_2 N}{a_3}\right) + \ldots + \cdot 33\, A_2,$$

where A_2 is the number of ampere-turns on the armature.

If the machine is to be shunt-wound, and N is the induction corresponding to the E.M.F. at full load, A_1 gives the ampere-turns on the shunt. If it is to be compound-wound, and N is the induction at full load, A_1 is the number of ampere-turns on the series and shunt windings added. The ampere-turns for the shunt alone are obtained by substituting for the induction at full load the induction on open circuit, the armature coefficient being of course here omitted. As a matter of fact, the value of v_2 increases between 0 load and full load, but for reasons already given this may in the calculation be neglected.

If the series coils are connected in series, to get the number of compensating turns on each horse-shoe we have only to multiply the external conductors on the armature by ·165. It may be mentioned in passing that in the Phœnix dynamos the total series convolutions for ordinary compound machines are uniformly ·31 of the convolutions on the armature; this, multiplied by the current, being the magnetising force necessary to overcome the resistance of the armature and the series coils, and to compensate the backward induction. It will thus be seen that rather more convolutions are required for the latter purpose than for the former, and I think that in most dynamos of medium size the relation is very similar. The only extraordinary relation I know of is in the Victoria machine, where the compensating turns, instead of being a little greater than the turns required to overcome the resistance of the armature and series coil, are three times as great.

11. Working Temperature.

The ultimate rise in temperature of coils wound with double cotton-covered wire, varnished on the exterior, is, approximately, in degrees Centigrade,

$$C^0 = \frac{W\ 355}{S},$$

where W is the rate at which energy is dissipated in watts, and S the cooling surface in square centimetres. If, for the latter, we substitute square inches, S_1, the equation is

$$C^0 = \frac{W\ 55}{S_1}.$$

The coefficients have been obtained from practice, but they are liable to some uncertainty. In the cases from which they have been derived the coils were wound on formers of sheet iron, which fitted close to the magnets. These formers were fitted with brass end flanges, and in the spaces between the flanges and the wire, also between the body and the wire, was a thick layer of insulating material. The surface of the end flanges is not included as making up S or S_1, nor is the inside surface of the former next the magnet. Though insulated so well thermally, there is certainly a flow of heat towards the interior of the magnets and towards the end flanges, so that, as a matter of fact, the virtual cooling surface is greater than given above. Its value it is, however, difficult to determine, while the above equation is approximately true for machines of medium size, and may be used for all cases in which the coils do not exceed 2½ or 3 inches in thickness.

For armatures—which in rotating induce a current of air—the equation is different, and the coefficient given above may have a much lower value, according to the velocity and ventilation. For armatures the surface velocity of which is 50ft. per second (3,000ft. per minute), and the exterior diameter of the core 1½ times the interior, the length being about equal to the diameter, the rise is, approximately,

$$C^0 = \frac{W\ 225}{S},$$

or

$$C^0 = \frac{W\ 35}{S_1},$$

accordingly as the surface is taken in square centimetres or square inches. Here the whole of the cooling surface inside, outside, and at the ends is counted, W being the total watts dissipated in both electrical waste and hysteresis. The latter must, under no circumstances, be neglected, as it may reach 20 per cent. or more of the total. In giving the above equation, it should be stated that the armatures of the machines which furnished the results are closed at the commutator end, except at the periphery, where a draught of air through the centre from the pulley end is expelled. For slow-speed machines the coefficient is necessarily higher, and a larger surface must be allowed, or special means adopted, in the shape of vanes or blades, to force a draught through the armature. Experience only can be the guide here.

Considerable difference of opinion exists with reference to the temperature rise which should be permitted in dynamos. The rise of about 11° C. allowed by the Admiralty is admitted by all engineers to be absurdly low; while, on the other hand, the machines sent out by some manufacturers get at their normal output dangerously near the temperature at which the insulating material would become useless. We have to steer between these two extremes, working far under the critical temperature, but, at the same time, not making machines too costly on account of the excessive surface allowed. It will be observed that from the manufacturer's point of view the settlement of this point is of great importance, since a competitor, by allowing a greater temperature rise, may put in a machine of less weight, and therefore less costly, though not necessarily less efficient.

In any case, the ultimate temperature of the machine ought not to rise above a certain value, whatever the temperature of the room in which it works. In my opinion, an ultimate temperature of from 70° to 75° C. may be permitted with perfect safety, but this should not be exceeded. Independently of the ultimate temperature, the rise in working should not be too great, and accordingly we have in the Phœnix dynamo fixed this limit at from 30° to 35° C. Machines working in atmospheres up to 35° C. have a cooling surface, therefore, which will give in continuous working a rise of 35° C.; when the temperature is higher the cooling surface is increased, so that the maximum temperature does not exceed 70° C., the limit given. It will be seen from the formula that, for a rise of 35° C. in the magnets, the cooling surface is 10 square centimetres (1·56 square inches) per watt.

For armatures having the proportion stated, the surface requires to be about 7·3 square centimetres (1·13 square inches) per watt; but here it is less easy to formulate rules. Both interior and exterior surfaces are ventilated by the motion, the former generally being of a broken character, which aids the cooling. The temperature of these surfaces does not measure the temperature of the bottom layers of wire or of the armature core itself; and when I speak of a temperature of 70° C, I mean, of course, that of the hottest part. The difference of temperature between the interior of the core and the outside surfaces, in a machine of given carcase dimensions, depends on the gauge of wire with which the armature is wound. Obviously, the difference of temperature required to produce a given flow of heat depends upon the thermal resistance encountered, and, therefore, on the number of layers of badly conducting substance, in the shape of cotton covering, through which the flow takes place. For this reason, an armature wound with one layer of coarse wire requires a less cooling surface per watt to keep down the internal temperature than an armature wound with fine wire, even if the mass of copper is similar. In

Digitized by Google

practice, allowance for this is made by working the small-gauge wires to a less current-density. On account of the flow of heat being obstructed by badly conducting substances, armatures with cores constructed of wire always get hotter inside than those with plate cores.

Of course, it will be understood that the coefficient given for the rise of temperature will be greater for those armatures in which the central opening in the core is less than two-thirds of its external diameter. Where, for instance, it is half the external diameter, the inside radiating surface is diminished to three-fourths of that specified, and the temperature rise will be proportionally higher, unless a stronger draught of air is sent through the centre of the armature.

(To be continued.)

THE PRACTICAL WORKING OF THE ELECTRICAL SUBWAYS OF NEW YORK CITY.*

BY WILLIAM MAVER, JUN.

The customary reply to an inquiry as to what is the best arrangement for an electrical subway is, "Build a tunnel under the streets and place the wires on the walls within easy access of workmen, and into such a tunnel put also the gas and water mains, &c." Assuming that this would be a satisfactory solution of the underground question if it could be arranged, let us consider what the cost of such an arrangement would be. It has been estimated that a subway suitable to contain all the electric wires, gas and water mains of New York city would cost $430,000 per mile; and if such a tunnel were to be built throughout the entire route of the now existing electrical subways of New York city, the bill would foot up to nearly $30,000,000. This amount, it will, I think, be generally admitted, is virtually prohibitory of any such subway at present; and if that is the case the fact will perhaps make those who have had preconceived ideas in favour of a universal tunnel scheme more tolerant of the electrical subways we have, the practical working of which I am to endeavour to describe this evening.

It is very far from my intention to go into a history of the opposition offered by the different electrical companies to placing their wires underground. I can imagine, however, that there are many persons who, if told that the telephone, telegraph, high and low tension electric-light circuits, and even the "deadly" alternating circuits are to-night in this city working successfully underground in the same streets and on the same side of the streets, would reply, "If they really are working successfully there they have no right to be."

In New York city to-day there are 73 miles of electrical subways, and 1,017 miles of ducts. In these ducts there are 10,906 miles of telephone wire, 945 miles of telegraph wire, including fire-alarm telegraph wires, and 457 miles of electric-light wires. These subways have a capacity for about 45,000 miles of telephone and telegraph wires and 2,000 miles of electric-light wires.

Conduits.

There are in the New York electrical subways eight different conduit systems—namely, the Dorsett, the Wyckoff, zinc tubing in hydraulic cement, sheet-iron cement-lined pipe, wrought-iron pipe in hydraulic cement, wrought-iron pipe in asphaltic concrete, the Edison iron tube, and the Johnstone sectional cast-iron conduits.

The Dorsett system consists of blocks formed of a material the ingredients of which are pitch, coal tar, and fine gravel. The blocks are moulded, with tubular openings about 2½in. in diameter from end to end. The blocks are about 4ft. long and 1ft. cross-section. These blocks are placed end to end in the trench, and are joined together by pouring between the ends a liquid compound of pitch and tar, which speedily hardens. This compound is prevented from entering the ducts by sleeves, which are placed in each duct between the junction of every two blocks. There is about one mile of this conduit, containing 16 miles of ducts, on Sixth-avenue. It is used for telephone and telegraph conductors. This conduit was laid three years ago. So far as I can learn, it is in a fair state of preservation to-day—but not perfect; the blocks having in some instances sunk, and thus put the ducts out of alignment. It may be noted here that guide ropes, consisting of ¼in. tarred hemp, which were laid in these ducts when this system was constructed, to be in readiness when cables were to be drawn in, show plainly in numerous places signs of deterioration, said to be the result of dry rot, combined with the gases found in the ducts.

The zinc tube conduits are laid in 58th-street. The zinc tubing was intended to serve simply as a mould around which hydraulic-cement concrete was to be placed, with the expectation that when the zinc had corroded the tube formed by the solid cement would remain intact. About one mile of this conduit has been in successful operation for three years; but the difficulty attending *the construction* of a conduit formed in this way was so great, owing to the frailty of the zinc tube, which readily gave way under moderate pressure, that its use has not been further extended.

The sheet-iron cement-lined pipe conduits are made in single or multiple tubes of two, four, six or more ducts, as may be required, and in lengths of 8ft. The tubes are connected together by a ball-and-socket joint. These conduits are made as follows:—A sheet-iron tube 8ft. in length is held vertically; inside of the tube is placed a smaller brass tube, and semi-liquid cement is poured into the annular space between the brass and sheet-iron tubes. When the cement has solidified the brass tube is withdrawn. The cement tube is then ready for the subways. There are about 113 miles of ducts of this conduit in the subways, and during the coming summer it is expected many times this amount will be laid in New York City.

There are about 15 miles of creosoted wooden ducts in the subways known as the Wyckoff conduits. These ducts are formed of wooden piping similar to ordinary pump logs. There are lead-covered telephone cables in these ducts, and the action of the creosote upon the lead covering is being carefully watched. These ducts have been in operation for three years. I am informed that detrimental effects are noticeable in the lead-covering of the cables, which is alloyed with 3 per cent. of tin.

The bulk of the subway conduits consists of wrought-iron pipe laid in hydraulic-cement concrete. These pipes are 20ft. in length, and vary in diameter from 2in. to 3in. The thickness of the iron is ·217in. In laying all these pipe conduits, the bottom of the trench is first levelled to grade; planks are then set against the side of the trench to sustain it; a layer of concrete is then laid and rammed in the bottom of the trench; on this is placed a row of iron pipe, next a layer of concrete, then another row of pipe, and so on, until the desired number of layers is attained. There is placed over all a 2in. yellow pine planking, heavily creosoted, to protect the conduits against injury from picks, crowbars, &c.

The wrought-iron pipes are joined end to end by a coupling screw joint with a tapering or vanishing thread. By the use of this form of thread, I am informed, the rate of laying this pipe is increased 50 per cent. These tubes are delivered free from burrs, and have a smooth inner surface. The pipes are sometimes asphalted to prevent rusting; but should they in the course of time rust, it is expected, as in the case of the zinc tube, that the concrete will preserve the shape of the duct intact. There are close upon 550 miles of wrought-iron piping in the subways. The main reasons which have led to the extensive use of wrought-iron piping in the subways are its great strength, its adaptability to varying conditions of the street, and the rapidity with which it can be laid.

The subways are in many cases on both sides of a street, and, as a rule, the telegraph and telephone wires are assigned to ducts on one side of the street, and the electric light to ducts on the opposite side; but in numerous instances the electric light wires are operated in distributing ducts on the same side of the street as the telegraph and telephone wires, and without detriment to the latter.

Manholes.

Access is had to the conduits of the New York subways by means of manholes, placed at an average distance of about 1-25th of a mile apart. The manholes are, with a few exceptions, built of brick laid in concrete cement, with hydraulic concrete bottom. The outside of the walls is coated with cement, to prevent moisture and gas from penetrating. Access to the manholes from the street is had through the cast-iron head which is set on the brickwork, and which is provided with double covers. The upper or street cover weighs about 350 pounds. The lower cover is provided with a rubber gasket to prevent ingress of street water into the manhole. This cover is funnel-shaped, in order that any water which may enter through the upper cover may be drained away from the gasket. The lower cover is screwed down upon the gasket by a gun-metal bolt and cross-bar. The upper cover is loose upon its bearings.

Rodding.

The electrical subways of New York city, with the exception of the Edison system, are of the class known as the drawing-in-and-out systems. The first process in drawing a cable through a duct which is not easily accessible except at its ends in the manholes is obviously to provide a means of drawing in the cable. This is done by a process technically termed rodding, which consists of pushing rods through the duct from one manhole to the next. A rope is then attached to the end of the rod, and the rod is withdrawn, bringing the rope with it. This rope is then employed to haul in the cable. As some of the manholes are over 500ft. apart, and it would not be convenient to procure a continuous wooden rod of that length, rods of about 4ft. in length, fur-

* Abstract of a Paper read before the American Institute of Electrical Engineers, New York, February 18, 1890.

Digitized by Google

nished at one end with a screw, and at the other end with a screw socket, are used. These are placed in a bunch in the manhole, and are attached by the screws one to the other, as many as are required to reach to the distant end of the duct. The rods are then detached, as they are drawn out, by unscrewing the ends.

Drawing in Cables.

After the rope has been attached to the cable, the latter is then "threaded" through the duct. The manner of applying the force necessary to pull the cable through the duct depends upon the size and length of the cable. If it is a small cable, say 300ft. in length, it can be drawn in by two or three men. If it is a large cable, or if four or six small cables are to be drawn into one duct, as is frequently done, more elaborate drawing-in apparatus is used. This generally consists of some form of winch. The largest telephone cables are drawn in by a winch of special construction, in which the power is transmitted through the intervention of wheel gearing. As many as six electric-light cables, No. 4 B. and S. conductor, have been repeatedly drawn at once into a 3in. duct. As the weight of a No. 4 B. and S. lead-covered cable is, for 300ft., say 250lb., an idea may be obtained of the force required to draw in six such cables. I am informed that cables weighing in the aggregate 5,510lb. have been drawn at one time into one duct.

Methods of Distribution.

It is, of course, a comparatively easy problem to arrange an electrical subway for trunk-line circuits. The difficulty arises when the question of distribution of the current from the main conduits is to be considered. Distribution of the electric-light current is effected in several different ways in the New York subways. For street arc lamps the circuit is usually looped from the manhole to the lamp-post through a subsidiary iron pipe. For easy access to houses and to lamps in the middle of blocks, distributing ducts are laid above the trunk ducts as near the surface of the street as practicable, the average distance from the surface of the street being perhaps 18in.

The Johnstone sectional conduit has hitherto been the most extensively employed for this purpose in New York city. This conduit consists of sections of cast-iron ducts about 5ft. in length. The sections are placed directly above each other, and are held together when in position by removable clamp pins. The upper section rests in a groove in the lower section. Each section of the conduit is divided into from two to six or more compartments or ducts. the ducts being formed by removable partitions or slats held in position by suitable channels or grooves within the section. Opposite each house or every alternate house a handhole is provided in the upper section of the conduit. The handhole consists of a removable cover, about 2ft. in length, on the upper section, and the side of the section at this point is provided with a branch or spigot. This conduit is laid directly in the earth—not in cement. When it is desired to tap or loop the circuit, a 3in. iron pipe is run from the branch at the handhole to the basement of the house, or to the lamp-post with which connection is desired to be made. This iron pipe fits on to the spigot at the side of the conduit. Should the conductor which it is desired to tap be at the side of the section remote from the spigot, the intermediate partitions are removed to permit the passage crosswise of the connecting cable.

When a handhole has not been provided originally at a point where access is desired to a conductor in the conduit, the entire upper section is removed and replaced by a half section containing a handhole cover and spigot. These conduits are presumably made air and water-tight at the junction of the two sections and at the ends of the ducts, by the use of plumbers' putty. In view of the number of supposed opportunities for the entrance of moisture at these junctions, it would be naturally expected that this type of conduit would be in a chronic moist condition. Indeed, it has been predicted of it that the ducts would act as canals for the surface water, but, as a matter of fact, these ducts are almost invariably dry. There are two theories given to explain this fact: the first, that in reality the plumbers' putty makes an air and water-tight joint; the second, that if the joints are so imperfect as to admit water, they are quite capable of permitting its escape also. It must be said that this system has been found of much utility in the practical distribution of electric-light current in this city.

More recently a method of distribution in which wrought-iron pipes are used has been employed. This consists of a row of three or four iron pipes laid, like the Johnstone conduit, as near the surface as possible—in the earth, without concrete. Opposite every party wall, or, in other words, at distances of about 50 feet apart, iron boxes about 18in. square are placed. Then these boxes have removable covers. The ducts enter at the ends of the box, but do not pass through it. The boxes are provided with side openings also for the entrance of the subsidiary iron pipes. Access is had to these boxes also by the removal of the street paving and earth. This method of distribution has, like the one just described, been found satisfactory.

The Cables and Insulation used in the Subways.

In the telephone service in this city, the cables used are chiefly of the type known as the Patterson. This cable is constructed as follows:—Ordinary cotton covering is first placed around the wires. After the wires are cabled a lead covering is placed over them, and paraffin is then forced into the interstices between the conductors and lead covering. This cable has an electrostatic capacity of about 0·16 microfarad. The insulation resistance of the cable, laid and jointed in the subways, averages about 100 megohms. The longest stretch of cable used by the telephone company in the subways is seven miles. The greatest number of conductors in any one cable is 100 or 50 pairs.

The telegraph companies have thus far used chiefly for underground service Kerite, Okonite, Standard Underground, and Patterson cables. The Kerite and Okonite insulation, it is well known, are homogeneous compounds. These cables are not lead-covered. Of course, they could be. The Standard and Patterson are fibrous cables, and are lead-covered. Except in the vicinity of the underground steam pipes, the unprotected homogeneous cables have given uniform satisfaction. But, as might be expected, the effect of escaping steam upon them has been detrimental. Fortunately, the heated area in the vicinity of the electrical subways is limited to a portion of the down-town districts. Investigation has shown that the heat only reaches a harmful temperature in the neighbourhood of actual leaks in the steam pipes. Measurements of the temperature of a manhole in the worst section of the heated district have shown as high as 150° to 200° F. Since the starting of the blowers in this district to ventilate the subways, a noticeable decrease in the temperature is observable, and, inasmuch as the steam-heating company is achieving some success in its efforts to close up all leaks in the pipes, it is anticipated that the heat difficulty will be eventually removed from the subways. The users of the Standard and Patterson cables state that those cables are giving very fair service in the heated portions of the subways, although the high temperature, of course, lowers the insulation resistance of the cables. The average number of conductors in the telegraph underground cables is about 50. The size of the wire used is, as a rule, No. 16 B.W.G., and the outside diameter of a conductor, including the insulation, is $\frac{5}{32}$ of an inch. The insulation resistance of the Okonite insulation is about 2,500 megohms; that of Kerite 500 to 800 megohms, and that of the Standard and Patterson about 1,500 megohms, per mile for the thickness of insulation just mentioned. Outside of the injury to the cables due to the presence of the steam-heating pipes, no undue deterioration of the telegraph cables in the subways has been noted.

(To be continued.)

STANDARDISATION OF POTENTIALS ON STREET RAILWAYS.*

It was deemed advisable by the members of the committee to send out a circular to all railway companies operating their system of car lines by electricity, notifying them of the appointment of this committee, and asking not only their co-operation, but also drawing their attention to a number of questions that we desired they should reply to.

1. What system do you use?
2. What proportion of your cars are equipped with motors?
3. Do you generate your own electrical power, or are you supplied by an electric light station?
4. What proportion does your greatest average horse-power in use bear to the total horse-power of engines and boilers which you have installed?
5. What is the voltage or pressure of your generators?
6. Is there any other railroad in your town using an electric system? If so, what system do they use, and do you know the pressure at which they run?

We have received replies from 85 per cent. of all the electric street railway companies. They have, one and all, showed every disposition to give us full reports upon the questions that we have asked them, and have stated that they would afford us every facility that lay in their power, and that they desired us to convey to the National Electric Light Association their hearty endorsement of this plan.

Question 1.—Fully 90 per cent. of all the railways now in successful operation are operated under the systems controlled by the Thomson-Houston and Sprague Companies.

Question 2.—We find that at least three-fourths of the railways have equipped all their cars with motors, and that the sizes of the motors upon the cars vary from 7 1-2 to 15 H.P.

* Abstract of the Report of a Committee of the National Electric Light Association, presented at the meeting at Kansas City, February 1, 1890.

Digitized by Google

Question 3.—Only nine electric light companies have been brave enough to agree to supply the street railway companies with their power, although in nearly every case when the railway was in operation there was at least one central station company who could have contracted to supply the necessary current.

Question 4.—In all railways operating over fifteen cars only one-third of the total horse-power with which the plant has been equipped has ever been called for at one time. On all roads operating between five and fifteen cars the greatest average load has not reached 50 per cent. of the total horse-power, and upon smaller roads the average load has varied from 50 to 80 per cent. of the total horse-power. All roads that have met with heavy grades have raised the average very considerably.

Question 5.—We find that the potential varies from 220 to 800 volts. The greater number of companies, however, report using a potential between 450 and 550 volts.

Question 6.—The answers to this have been many and curious. In some cases they have disowned all knowledge of the existence of any other company, and in nearly every case they seem to be imbued with the rivalry quarrels or misunderstandings of the various parent or manufacturing companies whose apparatus they are using.

Copies of the circulars, together with a letter explaining more fully the plan suggested by your committee, were sent to all the manufacturing companies. They were also requested to furnish the committee with a list of the particular railways operating under their systems. After much correspondence and many personal interviews your committee would announce that they have written authority from both the Thomson-Houston and Sprague Street Railway Companies to make the statement, on behalf of their particular companies, that they will agree hereafter to use a standard potential of 500 volts upon all electric street-railway equipments that do not require any special apparatus for their successful operation.

In recommending electric light companies to add to their regular central station business the business of furnishing power to street railroads, we wish it fully understood that we do not base any hopes of profits to be made upon the old-time idea that the same machinery can be used for furnishing light at night and power in the day-time. This specious argument has led many companies into large expenditures for motors, &c., and they have discovered later that it costs very nearly twice as much money to run the same machinery night and day as to run it at night alone, and that it pays better in the long run to have an entirely different class of apparatus to produce light and power. The true direction from which returns may be expected, in the massing in large stations of the generation of electricity for both light and power, is found in the fact that any electric light station, to be sure of continuous running, requires a reserve of from 15 to 25 per cent. of its average load in boilers, engines, and dynamos; the percentage being larger in small stations, and diminishing as the station increases in size. This same reserve in capacity is required for the power station; but on street-car work, in most of the stations hitherto installed, this percentage runs very much higher, being from 50 to 80 per cent. Now, if any one station supplying electricity for all purposes in a town we have say 25 per cent. reserve in boilers, and 25 per cent. reserve in steam engines, in excess of the average load, we shall only require to place 25 per cent. reserve each on electric light dynamos and power generators to have practically the same result as though we had two complete and separate stations for electric light and for electric power, each with its proper reserve of 25 per cent. extra in engines and boilers and dynamos.

As an instance of what may be done in increasing the output of a station without a corresponding increase in expenses, we quote the case of a small station, which, as nearly as can be determined from results, shows the following condition of affairs. The station increased its business in 1889, over 1888, 23 per cent., and in the same time the total expenses, including the extra line work and distribution expenses, 10 per cent., which 10 per cent. meant 10 per cent. increase in running expenses and 10 per cent. in fixed expenses. The Company contemplates a further increase of 27 per cent. on the same basis; this increase, however, being for power furnished alone, without any line work involved, the most careful calculation shows that this will only increase the present running expenses 10 per cent., without increasing the fixed charges at all. In 1888 the fixed charges and running expenses were 25 per cent. and 75 per cent. respectively of the total expenses. In 1889 this same proportion held good, each having been increased 10 per cent. as above stated, and the total expenses having increased the same amount. The further expected increase, being 10 per cent. of 75 per cent., will mean an increase in the total expenses in 1890 over 1888 of 17 1-2 per cent., while in the same time the total output of the station and consequent gross receipts will have increased 50 per cent. These figures are all taken from the case of a small station, with a total output of some 350 horse-power, and a fresh increase in this station (above this point) will result in an entirely different condition of affairs, so that a readjustment will take place in the proportion of fixed expenses and running expenses. We therefore present the report of another station, which is operating 1,200 horse-power, in which the total operating expenses are divided into 80 per cent. running and 20 per cent. fixed. On increasing the station to an output of 1,800 horse-power; the increase to be entirely in the furnishing of power, the increase on total operating expenses would be about 14 per cent., and the ratios of fixed and running expenses would be as 15 per cent. and 85 per cent.

The great saving for the central station company lies in the reducing in labour and fixed charges, and also that the reserve power for one will suffice for the other. Your committee feel that a great step has been taken in the right direction in securing the endorsement and co-operation of the largest and leading companies, and they would suggest to the Association that some measures be taken to secure from the stationary motor companies the adoption of some standard potentials for their use upon constant-potential circuits.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

The following paragraphs of our New York correspondent's letters were held over last week owing to the pressure on our space. Up to the time of our going to press our New York letter for this week had not come to hand.

The Cincinnati Telephone Company and the Single Trolley System.—Going counter to a number of decisions rendered in favour of the railroad interests, Judge Taft, of Cincinnati, has decided against the single trolley system there, and has ruled that the double trolley system must be used. The decree, however, is subject to a stay of six months, and even then is open for extension, and in the meantime the electric railway companies have taken immediate action for an appeal. Judge Taft held that the telephone people have used their present system for eight years along the streets occupied by the railroad companies. The usual method of conducting the telephone business had been to use the earth as a return circuit in the outgoing wires, and the company had a lawful franchise to operate such a system. The railroad company also had a right under the law to use electricity to propel its cars, but it did not have the right, in the absence of express Legislative authority, to use such a system as would disturb and injure the business of the telephone company unless it should be shown that there was something in their manner of constructing the railway which would not create such disturbances as have been complained of. He considered the evidence to show that the double trolley system was practicable electrically and mechanically, and would do away with the trouble; whereas, on the contrary, while the telephone people might cure the trouble by using a metal circuit on each of its lines, that would involve such an enormous outlay of money as to be prohibitive, while a more economical arrangement would only partly relieve the difficulty. The single trolley was, therefore, a legal injury to the plaintiff. It has been remarked, I may add, that the metallic system was long ago approved of and recommended by the leading telephonists themselves, and that it has already been found necessary in such cities as New York, for instance, where there are really no electric railroads.

Attempts to Restrict Voltages.—A serious effort has just been made in the State of Virginia to restrict voltages. A hearing on the subject was had a few days ago at Richmond, in which no less an important and distinguished personage than Mr. Edison took a part, his presence there bringing together a crowded and representative audience. The proposal was opposed by nearly all the local companies in the State; and the Committee of the Legislature having the matter in hand, after hearing all the pros and cons, decided unanimously to report against the proposed measure. In New York State we now have promise of a similar attempt, there being a Special Committee of Investigation from the Legislature, which has begun to hold meetings and call witnesses, and whose object seems to be the establishment of the contention that high voltage currents should not be allowed. There are about 75 or 100 local companies in this State, and it is believed that nearly every one of them will oppose tooth and nail any limitation of voltage.

Digitized by Google

PARIS NOTES.

(FROM OUR OWN CORRESPONDENT.)

March 11, 1890.

At the last *séance* of the Société des Électriciens, M. Reignier gave some interesting particulars with regard to the machine he is constructing in conjunction with M. Bary, and which I have alluded to in a previous letter. MM. Reignier and Bary have made a great point of reducing the resistance of the magnetic circuit. By diminishing this they have been able to employ a very small magneto-motive force, and consequently to greatly diminish the weight of copper; and the total weight of the machine for a given output is, therefore, at the same time considerably reduced. The method adopted by M. Reignier for reducing the resistance of the air-gap consists in winding the armature with a conductor composed largely of iron. The machine described by M. Reignier is of the ring type. The armature conductors are compound, and consist of a strip of copper, sandwiched between two strips of iron, and kept together by the insulating covering. But as in a ring the external surface is larger than the internal surface, the strips of iron are only on the outside. The machine, which has actually been constructed, has an output of 10·5 kilowatts (70 volts and 150 amperes) at a peripheral speed of 10 metres per second (33 feet per second), and at an angular velocity of 1,800 revolutions per minute. The machine weighs 263 kilogrammes (580lbs.). Its output for weight is thus 40 watts per kilogramme (18·2 watts per lb.). This figure is undoubtedly far superior to any hitherto obtained; and here are some comparative figures on the subject:—

Watts per kilogramme.	Edison.	Desroziers.	Rechniewski.	Reignier-Bary.
Machine	9	21	215	40
Armature copper	500	—	800	1,800
Total copper.....	92	250	270	445

I should remark that the figures of the Rechniewski machine correspond to a peripheral speed of 16 metres per second (52·3ft. per second). The efficiency tests of the Reignier-Bary machine were made at the Laboratoire Central d'Électricité, and the electrical efficiency was found to be 94 per cent., and the commercial efficiency 90 per cent. We are thus able to see that, without diminishing the efficiency, Messrs. Reignier and Bary have been able to increase in a very large degree the *puissance spécifique*. The advantages of this are so self-evident that it is not worth while to mention them further.

The Compagnie Continentale Edison is about to increase the capacity of its station in the Faubourg Montmartre by the addition of a large battery of accumulators, each to weigh about 800 kilogrammes, and able to discharge at the rate of 1,000 amperes. These accumulators, although of a special type, will be constructed on the lines of those made by the Société pour le Travail Electrique des Métaux, which possesses a large factory at St. Ouen. The Compagnie Continentale Edison has also purchased a site in the Avenue Vendaine, in the Quartier Rouchouart, where they intend erecting a 3,000 horse-power station, which will be connected to the one mentioned above.

Owing to the termination of the lease, the Standardising Laboratory of the Société Internationale des Électriciens in the Rue Saint-Charles will shortly have to be moved. The Conseil Municipal has offered a site in the Rue Thomond to the Société at a nominal rent, on the condition that the Société submits its plans to the municipality, and hands over to the town of Paris at the end of 60 years any building that may be erected. The Société is, moreover, to carry out gratuitously all tests and standardising required by the municipality, and to reserve two scholarships for pupils nominated by the town.

On Monday, February 24th, a judgment was given in the action brought against the State by the Société Générale des Téléphones. M. Emile Laurent considered that the concession granted to the Société by M. Granet in July, 1886, was *ultra vires*, and had no legal value, not having been approved by the Chamber. M. Laurent at the same time appointed a committee of experts to estimate the value on September 1, 1889, of the telephone material belonging to the Société, and to fix the loss sustained by the Société by reason of the non-working of their system from September 1, 1889, the date of its being taken over by the State, to the 8th of the same month, the date of the termination of the concession. The committee of experts will consist of three members, one nominated by the State, one by the Société Générale des Téléphones, and the third by the Conseil de Prefecture de la Seine.

VIENNA NOTES.

(FROM OUR OWN CORRESPONDENT.)

VIENNA, *March* 10, 1890.

The telephone service between the Bourses of Vienna and Budapest has been opened since January 1st. Three metallic circuit lines were run, two for the Bourse and one for the Exchange subscribers. The experiments, however, proved that when the three lines were used the induction and overbearing were so great that the use of the third line had to be abandoned, and only two used, though even then there was a great deal of overhearing. The lines were run, against the advice of the Austrian chief electrician, on a plan proposed by the Hungarian engineers; they are so twisted and crossed that contacts are constantly occurring, and a fourth circuit cannot be added without taking down the existing lines. If a fourth circuit could be added, and all four run on the plan proposed by Mr. Preece, there is little doubt that four could be worked where at present it is impossible to work three circuits. The line is run with 3 mm. silicium bronze wire.

The success of the Vienna-Prag line has created a demand for further trunk lines, and the Government propose this year to connect some of the larger Bohemian towns with Prag, to connect Reichenberg with Gablonz, and to run a separate line to Brünn, giving up the present line worked on the Van Rysselberghe system. Brünn is then to be connected with Prag, thus giving an alternative route from Prag to Vienna. The Vienna-Prag line runs through a district called the "Forrest quarter," about thirty miles from Vienna. Here the ice and snow freezing on to the wire, frequently 10-30cm. thick, caused frequent breakages to the silicium-bronze wire, interrupting the service. In order to meet the difficulty this part of the line has now been run with 5mm. iron wire, a distance of about 30 kilometres; the result has been so far very good, and the experiment has in nowise affected the good working of the line, speaking being as clear as before.

The Town Council of Vienna has published an elaborate account of the cost of their electric light installation in the Town Hall. There are in use 1,141 glow lamps and 17 arc lamps; these have burned 134,943 hours for the glow lamps and 18 for the arc lamps, an arc-lamp hour being reckoned 270 glow-lamp hours. These have cost 7,757·37fl., or 5·74 kreuzers (about 1½d.) per hour. It must not be forgotten, however, that the Town Hall is heated by steam, and that the same boilers are used to drive the dynamo engines which supply the heat to the whole of that vast building.

In Budapest the Town Council have given permission to the tramway company and Messrs. Ganz and Company to run a short experimental electric tramway through the town on the Zipernowsky one-rail system. Telephonic communication will shortly be established between Budapest and Szegedin. Messrs. Siemens and Halske are erecting a lead cable factory in Vienna.

CORRESPONDENCE.

ELECTRIC TRACTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR,—"Figures may be made to prove anything." Thus you echo the remarks of Mr. H. J. S. Heather; and, borrowing another phrase from the same correspondent, "I think we are justified in relying on figures if they are put together with some regard to common sense." Mr. Heather mentions among the traction expenses the wages of the driver, which is never included in the "horsing" estimates of tramway companies. It is very doubtful whether car drivers can be obtained for the figure given, viz., ·6d. per car mile, the average distance travelled by London cars being 70 miles per day, which would allow the driver only 3s. 6d., whereas as a rule he gets about 6s. per day.

Working on the basis of 70 miles per car per day, I will now endeavour to show how the items in my letter of August 23, 1889, are obtained.

1. Renewal of accumulators one penny per car mile. This represents 25,550d. per annum. Including reserve, there are about 3,000 plates used in the batteries of 150 ampere hours' capacity each. We should thus get 8½d. per plate for renewal The material for new plates costs about 3¾d., but the old material has a value of at least 50 per cent. of the new; consequently, we have still a balance of over 6½d. per plate for labour and profit. A most desirable business for anyone who understands it, whose works are not hampered with a huge capital, plus debentures,

Digitized by Google

and whose administration and office expenses can be kept considerably below £10,000 per annum.

2. Cost of electric energy, inclusive wages and depreciation, 1·64d. Allowing a large margin, I take 2 indicated horse-power hours per car mile, or about 10 per cent. more than Mr. Heather. A moderately economical steam plant of not less than 200 horse-power capacity should not cost more than £10 per horse-power per annum of 3,600 hours, as is the case in many factories and mills. This amount includes all possible charges, and refers to London prices of coal and labour. Our car requires a maximum of 140 horse-power hours per day; therefore, on the basis of £10 for 3,600 hours we obtain 1·33, to which we can add ·31d. per car mile for dynamos and switches, depreciation and attendance.

3. Motors and gearing at ·75d. gives close upon £80 per annum, equal to 30 per cent. on the gross price of the whole electrical equipment on the car, excepting accumulators.

I have no authentic information as to the cost of traction at Barking-road; but I know that the success or failure of this system will mainly depend upon the prime cost and maintenance of the accumulator. I am now experimenting with a storage battery which is made without "paste, paint, cement, or powder," which gives a higher discharge rate with less weight than any pasted type, and which, whilst being tolerably cheap to produce, promises a depreciation of less than ¾d. per car mile; and with this I hope to bring the cost of accumulator traction down to the desired "threepence."—Yours, &c.,

London: March 10, 1890. A. Reckenzaun.

THE WYNNE SYSTEM OF ELECTRIC TRACTION.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Prof. Ayrton's letter on my system of applying electricity to tramways contains the claim for priority which may confidently be expected from him whenever any electrical invention is made public.

The sneering allusion to my supposed American nationality, and to the extreme youth of my invention, as well as a slang expression which I do not understand, may be passed over with the silence they deserve. I shall, therefore, confine myself to dealing with Prof. Ayrton's specific claim to priority.

Prof. Ayrton bases these claims on his and Prof. Perry's patents, Nos. 783, 1881, and 2,395, 1883.

As I stated in my former letter, patent 783, 1881, refers to mechanical means of connecting sectional insulated rails of considerable length with a main insulated conductor, and for the single expressed purpose of reducing leakage of the current supplied to electrical trains.

That the sections of this insulated rail are of considerable length is apparent from the following quotation (patent No. 783, 1881, page 9, line 23, *et seq.*):—"In all our arrangements previously described the distance between each contact box and the next varies from about 20 to 50 feet, so that there are several contact boxes in each section of our insulated rail, and several sections of an insulated rail in one section of the line blocked; but the following illustrates one of our methods for making each section of our insulated rail or conductor which is rubbed by a passing train, a mile or more in length—in fact, as long as the particular system employed to insulate the rubbed conductor will allow." It is clear that the use of sections made so short as to provide for the protection of the public by keeping those sections which are charged under the car, has not occurred to Profs. Ayrton and Perry; in fact, from beginning to end of these patents there is not one word to show that the Professors had any other ideas than that of modification of Prof. Fleeming Jenkins' system of electrical trains; not one word as to the special difficulties of applying electricity to urban tramways, or to means for overcoming these difficulties.

I must also traverse the statement which Prof. Ayrton makes in his letter, in the following words:—"Then it is explained that the insulation of a conductor on the ground, as, for example, the ordinary rail, is sufficient in certain cases to enable it to be used as the sectional conductor."

Will he kindly point out where this explanation occurs? The sentence immediately preceding the above is a quotation from the *final* specification; the two lines he quotes in support of the above are from the *provisional* specification, and occur in the following sentence, which is markedly omitted in the final (783, 1881, page 2, line 28, *et seq.*):—"We may modify our apparatus by dispensing with a third elastic rubbing rail as before described, *insulating instead by the best known means* one of the carrying rails, dividing and insulating the said rail at the usual fishplate or other joint into sections of suitable length, insulated from one another as perfectly as may be. Contact between such sectionally-insulated rail and the main well-insulated conductor may be made by the wheel tire or special roller pressing upon long rods parallel to the rail with contact pieces at their ends." The italics are mine; there is not even in this any suggestion that they should be insulated at *each* fishplate joint. The contact boxes are specified 20 to 50 feet apart, and the insulated sectional rail lengths are some multiple of these distances.

A large portion of this patent is devoted to very ingenious methods of automatically blocking the line, so as to prevent the possibility of collisions between the trains; and with this portion of the patent I have at present nothing to do, as it in no way applies to tramways. The only reference to an electrical method of making successive connections between the long sections of the insulated rail and the main insulated conductor is partially quoted in Prof. Ayrton's letter; but, for the information of your readers, I will give the whole quotation (of 12 lines out of a patent of 12 pages), and thus enable them to judge how far the claims put forward can be substantiated by the patent of 1881. The passage occurs on page 15, lines 7-17, and runs as follows:—"Instead of the mechanical plungers shown on sheet 2" (referring only to sectional conductors a mile or more in length) "for automatically connecting the main cable with the section just entered by the train, and for automatically disconnecting the main cable from the section the train is leaving, we may use electric means for this purpose based on the wheels, rollers, or brushes on one side of a carriage, completing the electric circuit through the wheels, rollers, or brushes on the other side, or based on the wheels, rollers, or brushes in the front of a carriage or train being in connection with the insulated section just entered on, whilst the wheels, rollers, or brushes in the rear of a carriage or train are in contact with the insulated section being left, and so connecting for a short time the two insulated sections electrically together; or we may employ a magnetic arrangement depending for its action not on the weight of the train, but on its magnetic mass."

Parenthetically, I may remark that Profs. Ayrton and Perry limited themselves in the above quotation to the application of electrical means of connection to the devices shown in sheet 2, which have all reference to sections "a mile or more in length;" and in their patent 2,395, 1883 (which, it should be noted, is subsequent to mine, 1,791, 1883), this limitation, for good reason, as I shall show, is persisted in.

Dr. Hopkinson took out a patent in October, 1882, No. 4,718, in which he described an electrical method of connecting a sectional rail to an insulated main conductor, that method being based upon the difference of potential produced by the motor of the train acting as a generating dynamo when cut off from the main (on entering an unconnected section). This method Messrs. Ayrton and Perry, in their 1883 patent, claim as being that which they intended to describe in the quotation which I have already given you from their patent of 1881. This is what they say (2,395, 1883, page 21, lines 8-11):—"His (Dr. Hopkinson's) method of actuating the box is that previously suggested by us in our original patent No. 783, 1881, page 15, lines 12–16, and used by us in the method illustrated in Fig. 20 of this specification."

A reference to lines 12-16 on page 15 of the 1881 patent quoted above, will show those of your readers who may not already be aware of the fact, how prone Prof. Ayrton is to read his knowledge of the present into his hints of the past.

To return to the 1883 patent, in it electrical methods of connecting the sectional rubbed rail to the main conductor are shown, the methods of connection depending on a short-circuiting of the main current as the train passes from one section of the rubbed sectional-insulated rail to another. That such a plan

Digitized by Google

could be worked I have no doubt; but it is evident that it could only be applied in cases (as the inventors themselves specify) where the sections are a mile or more in length, as it is only under such conditions that the contact boxes could be subject to the supervision which they would evidently require, on account of the heavy spark which must result in them as a consequence of breaking such short-circuit. The patentees were evidently aware of this objection, for they propose to reduce it by introducing a double winding on to their magnets, one of which shall be of high resistance. The remedy, however, is as bad as the disease; as the self-induction of the high-resistance coil would yield a spark quite as hurtful as the one it is intended to avoid.

I do not claim absolute immunity in my system from sparking; but the small spark which can occur, *is not in the closed contact box*, but at the end of the sectional surface road bar, which is built to withstand hard usage, whether electrical or mechanical. This is effected by the plan of electrically charging each section in advance of the one actually rubbed by the car contact.

Prof. Ayrton is evidently so well acquainted with the various patents which have been granted to me for the application of electricity to tramway working, that he will not be surprised to find that in my patent (No. 1,791, of April, 1883, page 2, lines 12-30), I specify the use of secondary batteries carried by the tramcar to influence, through a magnet also carried by the car, a carrier or contact-maker between the insulated conductor and the sectional conductor, thus anticipating his patent of 1883 by a few months.—Yours, &c., FRANK WYNNE.

5, Westminster-chambers, March 11, 1890.

TO THE EDITOR OF THE ELECTRICIAN.

SIR,—I read with considerable interest the report upon the Wynne system of electrical traction which appeared in your issue of the 28th ult., because only about a year ago a model of a system having exactly the same objects and securing the same advantages in a much simpler manner was exhibited at Westminster, and I believe inspected by one of the gentlemen making the report.

This model is at present in Liverpool. It illustrated a system in which a central conductor is laid in short sections separated from each other, the charged section being always covered by the car. There is no slot in the roadway or any obstruction to traffic, while all complicated appliances stowed away in contact boxes under the street are dispensed with.

I mention this as likely to be of interest when read in connection with the somewhat extravagant amount of laudation bestowed upon Mr. Wynne's no doubt excellent system, and to show that "electricians in this country" did not by any means confine their attention to accumulators and slotted conduits, or yet to "overhead conductors."—Yours, &c., C. B. B.

LEGAL INTELLIGENCE.

Chamberlain and Hookham (Limited) v. Cadogan Electric Light Company (Limited).

At the Birmingham County Court on March 5th, before his Honour Judge Chalmers, Messrs. Chamberlain and Hookham (Limited), 4, New Bartholomew-street, Birmingham, electrical engineers, sued the Cadogan Electric Light Company (Limited), 91, Manor-street, Chelsea, Brompton, London, for £31. 10s., the price of two electrical meters. The defendants counter-claimed for £25, loss alleged to have been sustained by failure of the meters to register electricity supplied to customers.

Mr. Hugo Young was for the plaintiffs; Mr. Ruegg for the defendants.

The defendants, on receipt of plaintiffs' circular, advertising the Hookham patent electrical meter as a reliable apparatus, arranged for the loan of a meter, and subsequently ordered two. The meters did not act; complaints were made, and it was found in one case that the armature was out of order, and in the other case that the friction wheel was untrue. Even after being put right the meters did not satisfy the defendants, and when the purchase money was demanded they declined to pay, and now contended that as they had ordered "reliable" meters, and the meters in question were not reliable, plaintiffs must accept a return of the machines and pay damages for loss sustained through their inefficiency.

Mr. HUGO YOUNG argued that this case came under the law governing contracts for well-known merchantable goods, and alluded to decisions indicating that a purchaser who ordered and received a well-known merchantable article could not refuse payment even if the article did not suit his purpose.

Mr. RUEGG argued that the defendants did not know of Hookham's meter till they received the circular; that the meter was not a well-known merchantable article; that the circular and correspondence amounted to an expressed or implied warranty that the meters should be fit for the purpose for which they were supplied. Even with regard to patent articles it would be a good defence to an action that the articles had not met the purpose for which they were intended.

After prolonged argument, his Honour said there was no question that the meters had been ordered, supplied, and accepted. They were patent meters, and had not been invented very long; they were very delicate, and dealt with a highly complicated subject-matter. Probably no perfect meter existed at the present time, but there was no question that under certain conditions the Hookham meters did work well for a certain period. No doubt the meters supplied to the defendants were made and tested in the ordinary manner, and there was no pretence for saying that they met with any accident in transit. Defects were subsequently found, but there was no evidence as to how the defects were caused, and in any case the defects were not organic faults.

Mr. RUEGG relied upon the correspondence and plaintiffs' circular as forming the contract on which the order was given. But it seemed to him that defendants made inquiries, heard plaintiffs' representations as to Hookham meters, and then ordered Hookham meters. If those representations were made honestly—and no doubt they were—they did not amount to a warranty. The circular was an ordinary trade circular. Every inventor issued such a circular, and honestly praised his patent; and so long as the praise was honest and correct, the inventor was not liable under questions of warranty. Still, a man of business, buying a patent article—especially a new article—dealing with a highly complicated subject matter, attempting to solve a problem not hitherto solved, would naturally protect himself by saying, "I will take this on approval, or I must have your specific guarantee for it." That seemed to be the business-like way in which a purchaser would protect himself. If he did not so protect himself, and both he and the seller honestly thought the article would answer the purpose in view, the purchaser must take the risk. There was no express warranty in this case, and there was no implied warranty—the rule *caveat emptor* applied.

Judgment for plaintiffs on claim and counter-claim; execution stayed pending appeal.

Radcliff v. Great Western Railway Company.

At Torquay County Court, on Saturday last, before Judge Edge, Mr. William Radcliff, electrician, Torquay, sued the Great Western Railway Company for 10s., damage caused to Edison Swan incandescent lamps in transit from London to Torquay.

Mr. LAMBERT, solicitor, Paddington, appeared for the Company, and Mr. RADCLIFF conducted his own case. He stated that, when he opened the box containing six lamps, he found the filaments of two broken. A special glass rate had been charged in order to secure safe transit. He attributed the breakage of the filament to jolting.

Mr. LAMBERT, in defence, contended that the lamp in question was a defective one, and that the fact that the glass was not broken showed there had been no negligence on the part of the railway company.

After laying stress on the absence of any notification as to the contents of the box, his Honour non-suited the plaintiff.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning.*]

TENDERS INVITED.—The Council of the Borough of Brighton will receive tenders for—(*a*) The erection of an engine and boiler-house, with chimney, shaft, and other buildings at the Corporation Electric Lighting Station in North-road, in the said borough; (*b*) The supplying and fixing of two Lancashire boilers: one double-furnace tubular boiler, and one feed water-heater; (*c*) The supplying and fixing of four sets of steam dynamos; (*d*) The supplying and fixing of electrical storage batteries; (*e*) The supplying and fixing of electrical instruments, apparatus, and appliances; (*f*) The supplying and fixing of electrical cables, wires, and protections in certain public streets in the borough; (*g*) The supplying and fixing of street and other boxes, junctions, apparatus, and connections, and apparatus to be used in the distribution of electricity; and the performance of certain other works in connection with the said several contracts. Further particulars will be found on page xv. of advertisements, and all other necessary information can be obtained of Mr. Francis J. Tillstone, Town Clerk, Town Hall, Brighton.

SALES BY AUCTION.—Tuesday, March 25th, is the date fixed by Messrs. Wheatley Kirk, Price, and Goulty for the sale by public auction, on the works premises, 417, Old Ford-road, Bow, E., of the modern engineering machines, tools, plant, and stores, particulars of which will be found on page iii. of our advertisements.

PERSONAL.—We have received a circular announcing that Messrs Mercier, Corlett, and Co. have started business as Electrical Engineers at the Arcade Electrical Works, King-street, Wigan.

Digitized by Google

The firm consists of Mr. Maunsell Mercier and Mr. G. Stephen Corlett, A.M.I.E.E., the latter of whom was for some years manager to Messrs. Sydney F. Walker and Olliver, and has been engaged for some time past in the application of electricity to colliery purposes. Mr. Corlett has carried out a number of successful installations of the electric light both above and below ground, and has had considerable experience in every branch of electrical work. The firm are agents for Messrs. Crompton and Co. (Limited), for Lancashire, North-West Wales, and Westmoreland, and are also sole agents of the same firm for Northumberland, Durham, and Cumberland.

——— Messrs. Girdleston, Tatham and Co. have commenced business as Electrical Engineers and Contractors at 16, Davies-street, Berkeley-square, London, W.

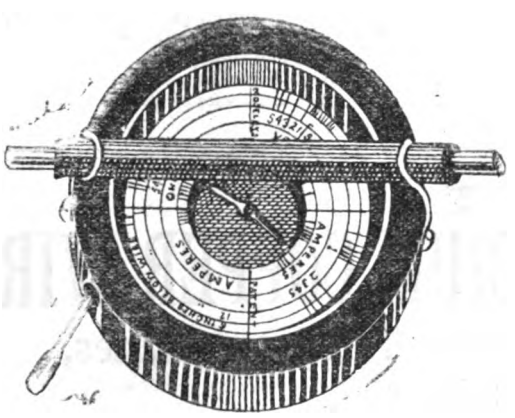
Dissolutions of Partnership.—The dissolution of partnership is announced of Messrs. W. T. Goolden and Co., of Westminster and Halifax, so far as regards S. C. G. Gold.

——— It is also announced that Messrs. Renshaw, King and Co., engineers, of Kidsgrove, Staffs., and Founders' Hall, St. Swithin's-lane, London, E.C., have dissolved partnership.

The Acme Electric Works.—We are informed that this Company has secured the order for making the numerous main and branch distributing switch and fuse boards required for the electric light extension at the General Post Office, and also an order for upwards of 2,000 Cockburn's patent fuse boxes and fuses for use throughout the same installation. Altogether the firm report trade very brisk, amongst the orders on hand being 30 large distributing boards, one of which is to control 5,000 lights.

Britannia Company (Colchester).—We have received Catalogue No. 3 of Engineers' Tools, Amateurs' Lathes, &c., just issued by this Company. The book consists of 104 large quarto pages, and contains illustrations of every description of boring, drilling, surfacing, facing, milling, planing, shaping, slotting, punching, shearing, screw-cutting, dividing appliances, adjustable keys, and similar machines, for which the firm is so well known all over the world. A portion of the book is devoted to descriptions of machines used in electrical engineering shops, particularly electrical engineers' drills; and on page 30 is an illustrated description of a gang of four quick-speed drilling machines, mounted on a cast-iron base, for drilling small holes of varying sizes, or countersinking, recessing, &c. Although the printing of the book is not quite so elaborate as that of some of the catalogues we have recently received, it contains a large number of capital illustrations. Scarcely anything used in engineering shops is missing from this catalogue, which is the most complete of its kind we have seen.

A New Compass Ammeter.—A pocket ammeter in the shape of a compass has recently been brought out by Mr. Walker Moseley. This instrument, which Mr. Moseley prefers to call an electrometer, can be suspended at different distances beneath a conductor, and being fitted with suitably graduated scales provides a ready means of gauging the strength of current flowing in a wire. The illustration, which is quite full size, represents the instrument suspended under a wire. For use as a voltmeter, Mr. Moseley supplies a fixed resistance in the form of a half-disc. The inventor claims that the instrument will perform quite a number of functions, and the low price at which it is sold will no doubt create a considerable demand for it.



International Exhibition of Machinery, Appliances and Inventions.—This Exhibition will open at the Agricultural Hall, Islington, London, N., on March 17th, and will remain open till March 29th. The Exhibition promises to be of an interesting character.

The Rating of Machinery.—The National Society for the Exemption of Machinery from Rating are issuing circulars notifying that the Bill for the exemption of machinery from rating has been ordered for second reading on April 16th. In order to secure the passing of the Bill, the Committee ask that every effort should at once be made to direct the attention of members of Parliament to the importance to all manufacturing centres of the Bill before the House. The question of the rating of machinery has a great interest for the majority of our readers, and we would call their attention to the fact that the National Society are prepared to forward on application forms and requisitions to be used in obtaining influential signatures which will have the effect of fortifying the position of those members of the House of Commons who have taken up the subject. The offices of the Society are at No. 22, Buckingham-street, Adelphi, London, W.C.

"THE ELECTRICIAN"

ELECTRICAL TRADES' DIRECTORY & HANDBOOK for 1890

The new edition of our well-known Directory and Handbook is now ready. The book consists of 850 pages, and has entailed this year an exceptionally heavy amount of work. The Handbook Division contains a mass of most useful information. The Directory Division consists of more than 400 pages, and contains a very carefully compiled Alphabetical and Classified List of Firms and Persons engaged in the Electrical and Allied Trades in all parts of the world. This Division has been corrected up to date, and the book is thoroughly reliable, even the very numerous changes which take place in the month of January being incorporated. The book is not a mere list of known and unknown Members of Scientific Societies repeated again and again. The Colonial and Foreign Division will be found extensive and reliable. The book has been very favourably reviewed by the Press. The price is 5s. 6d., post free in the United Kingdom.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

February 4, 1890.

1,867. J. A. McMullen. London. Improvements in electrical conduits and conductors.

1,878. J. B. Williams. London. Improvements in electric insulating compounds.

1,897. E. Fahrig. London. An improved composition applicable for electrical insulating and other purposes, and the process for manufacturing the said composition.

February 5, 1890.

1,939. M. H. L. Bougault. London. An automatic electric temperature alarm.

February 8, 1890.

2,080. J. C. Chamberlain. London. Improvements in devices for unloading, recharging, and reloading electric-car storage batteries. (Date applied for under Patents Act, 1883, Sec. 103, July 10, 1889, being date of application in United States).

2,091. W. P. Thompson. Liverpool. Improvements in secondary batteries and plates or elements therefor (the Gibson Electric Company of Europe, France).

2,108. C. T. Whitmore and W. H. Akester. London. Improvements in or connected with switches for controlling electro-motors.

February 10, 1890.

2,113. G. A. Schoth. London. Improvements in the manufacture of plates of electrodes as used in secondary batteries or accumulators.

2,153. D. Dewar. London. Improvements in telephone switchboards.

February 11, 1890.

2,172. H. Boardman. Bradford. A new or improved mechanical switch for completing and breaking the circuit of electrical tell-tales, for watchmen and the like, within a prescribed time.

2,199. S. C. C. Currie. London. Improvements in cores and armatures for electro-magnets and other purposes.

2,215. A. Schaefer. Hackney. The cure of stammering and stuttering, and for the cure of impediments in the speech—"the Electric Articulator."

2,234. S. E. Nutting. London. Improvements in electro-mechanical movements, chiefly designed for regulating the carbon in electric arc lamps and for similar purposes.

2,241. W. H. Robinson. London. Improvements in and relating to electric vote or indicator and recorder for legislative bodies.

February 12, 1890.

2,272. A. C. Cockburn and F. Teague. Kentish Town. Improvements in apparatus and devices for operating, compensating, regulating, measuring, and recording electric currents.

2,273. G. R. Postlethwaite. Birmingham. Improvements in voltaic cells or primary batteries.

2,296. J. C. Richardson and T. J. Holland. London. Improvements in the electrolytic production of caustic soda, caustic potash, and other products from their salts.

Digitized by Google

2,297. J. C. Richardson and T. J. Holland. London. Improvements in apparatus to be used for electrolytic purposes.
2,298. S. Gardiner. Glasgow. Improvements in and connected with electric calls and indicators for hotels.
2,302. H. Weymersch and R. McKenzie. London. Improvements in electric batteries working with two liquids or electrolytes.

February 13, 1890.

2,337. G. R. Postlethwaite. Birmingham. Improvements in electro-magnetic motors.
2,347. Sir C. S. Forbes, Bart. London. Improvements in primary batteries.
2,364. A. L. Davis. London. Improvements in portable galvanic batteries, and in glow lamps connected therewith.

February 14, 1890.

2,404. F. Bathurst. South Hampstead. Improvements in electrical switches.

February 15, 1890.

2,464. C. M. Dorman and R. A. Smith. Manchester. Improvements in electric light fittings.
2,476. A. H. Walton. Barnsbury. Improvements in fusible cut-outs for electrical circuits.
2,491. W. Gritten and A. Parmley. London. Improvements in casings, beadings, and mouldings, for containing, covering, and insulating electric wires for lighting or other purposes.
2,496. J. B. King and T. E. Bickle. London. An improvement in electrical conductors.
2,503. L. Saunderson. London. Improvements in electric arc lighting.
2,504. F. Wynne. London. Improvements in apparatus for propelling vehicles by electricity, and for protecting electric conductors.
2,506. E. C. F. Verschave and A. Baron. London. Improvements relating to electric batteries.

SPECIFICATIONS PUBLISHED.

1889.

2,472. Wise (Gibson Electric Co.) Secondary batteries. (Price 6d.)
4,371. Hookham. Electricity meters. (Price 8d.)
4,849. Boys. Insulators. (Price 4d.)
5,563. Lake (Lacombe and Co.) Electric batteries. (Price 8d.)
5,615. Timmis. Generating electricity on trains. (Price 6d.)
5,738. Fitch (Drummond). Insulating supports. (Price 6d.)
5,867. Graham. Telephone circuit switches. (Price 8d.)
5,955. Lancaster. Ceiling rose for electric circuits. (Price 6d.)
6,005. Van Depoele. Carbon contacts. (Price 8d.)
6,021. Shepard. Dynamo-electric machines. (Price 8d.)
6,171. Heap. Regulating, &c., electric currents. (Price 8d.)
6,568. Dorman. Dynamo-electric generators, &c. (Price 8d.)
6,569. Dorman. Dynamo electric generators, &c. (Price 8d.)
6,570. Dorman. Dynamo-electric generators, &c. (Price 8d.)
6,572. Dorman. Dynamo electric generators, &c. (Price 8d.)
7,138. Fitch (Drummond). Electric glow lamps. (Price 6d.)
7,506. Timmis. Electrically lighting railway trains. (Price 8d.)
7,719. Schoop. Electric cells. (Price 6d.)
9,496. Marx. Accumulating electric energy. (Price 8d.)
14,677. Moffatt. Electro-magnetically separating metals, &c. (Price 8d.)

1890.

272. Haddan (Williams). Electro-magnetic dispatch apparatus. (Price 8d.)
302. Lake (Alexander). Secondary batteries. (Price 8d.)
303. Lake (Alexander). Secondary batteries. (Price 8d.)
693. Currie. Electric motors. (Price 8d.)

Amended Specification.—1889.

11,927. Pitt (Atherton). Covering electrical conductors. (Price 8d.)

COMPANIES' MEETINGS & REPORTS.

Liverpool Electric Supply Company.

The annual meeting of this Company was held on Friday last, March 7th at their new premises in Highfield-street, Liverpool; Mr. A. H. Holme in the chair.

The report of the Directors, which the meeting was called to discuss, states that "the amount of net profit available for dividend, including the balance brought forward from last year, is £2,750. 13s. 7d. Out of this sum the Directors recommend the payment of a dividend of 3 per cent., absorbing £2,100, and to carry forward the balance to next year's account. The expenditure on capital account during the year (including a proportionate charge for general expenses) has been £52,957. For a business of this class it is obvious that the capital expended on land, buildings, and plant, must, in the early stages, be temporarily out of proportion to the possible earnings of the Company, as it is necessary to construct the generating stations, and to lay the underground mains on a sufficiently ample scale to meet not only the present but the future demand for the light. For example, the number of incandescent lamps on December 31, 1889, supplied from the Company's stations was approximately 6,400, whereas the mains, stations and plant were capable of supplying double that number. During the year the balance of the Company's share capital has been issued at a premium of 5 per cent. After protracted negotiations with the local authority, the Directors have succeeded in obtaining a Provisional Order for an enlarged area of supply, including Bold-street and other important streets which were not included in the original Board of Trade licence. The position of the Company is very much improved by the Provisional Order, which places its business on a thoroughly satisfactory and permanent basis. The demand for electric light steadily increases."

The CHAIRMAN, in moving the adoption of the report, congratulated the shareholders on the result of the year's working. Although the dividend declared was small, it had been well earned. Fresh arrangements have lately been made with Messrs. Holmes and Vaudrey. By these arrangements the Company secured the services entirely of the former gentleman, while Mr. Vaudrey would give his valuable experience in case Mr. Holmes was ill or not able to attend to his duties. This alteration did not cause any pecuniary difference to the Company. The increased demand for the light was very much in excess of their most sanguine anticipations. Indeed, few companies had come so prominently into public favour as this; hence it was natural to expect competition: but they had completed improvements by which they were enabled to defy competition, with due regard to material and workmanship.

Sir DAVID RADCLIFFE seconded the adoption of the report, which was supported by Mr. JAMES LISTER and Mr. DAVIDSON, and carried.

The retiring directors—Sir David Radcliffe, J.P., and Mr. Vaudrey—were re-elected, as was Mr. W. L. Jackson the auditor.

The meeting terminated with the usual vote of thanks to the Chairman for presiding.

PATENT
SILICIUM BRONZE AND SILICIUM COPPER WIRE.
The best for overhead Telephone and Telegraph Lines,
AND ALL ELECTRICAL PURPOSES.
Hard Drawn High Conductivity Copper Wire.
ROLLED AND DRAWN
PHOSPHOR BRONZE.
PHOSPHOR BRONZE
BEARINGS, BUSHES,
AND OTHER PARTS OF
ELECTRICAL MACHINERY.
SOLE PROPRIETORS of the British, Indian and Colonial Patents,
THE PHOSPHOR BRONZE COMPANY (Limited),
87, Sumner Street, Southwark, London, S.E.
WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

Digitized by Google

Exeter Electric Light Company (Limited).

An extraordinary general meeting of this Company was held on Tuesday at the Company's works, New North-road, Exeter. Mr. W. H. Ellis (Chairman of the Company) presided.

The SECRETARY (Mr. H. Michelmore) read the notice convening the meeting, which was called for the purpose of considering, and, if thought fit, to pass a resolution to the effect that the Company's Articles of Association be altered by the insertion of the word "ten" in the first line of Article 56, in substitution of the word "seven," so that the article might in future stand as follows:—"The number of Directors shall be ten, or such smaller number (not less than five) as the Directors may from time to time determine."

The CHAIRMAN, in opening the proceedings, remarked that the machinery in the Company's possession was now nearly all paid for, and if they had another engine and dynamo they would then be able to supply the large number of 6,000 lights instead of 3,000 as at present. The cost, however, would be about £2,000, and as the Company was short of capital, he suggested the advisability of shareholders taking up more shares themselves, and also inducing their friends to purchase some. They would then be able to supply the demands they were receiving, and accordingly increase their revenue; because the expenditure in connection with the supplying of 6,000 lights when they secured the additional machinery would be very little more than the cost of supplying 3,000. The Company proposed to add Dr. Woodgates and Mr. Joseph Dalke to the directorate, both of whom had consented to the proposal. He then moved the alteration of Article 56, so that it might in future stand as set out above.

Mr. C. J. B. SANDERS seconded the motion.

Mr. MASSINGHAM, the managing Director, observed that he hoped it was only a question of time—and not a very long time—before the Town Council would see their way clear to light the streets with electricity. They were rivals, but friendly ones, of the local gas company; but, at the same time, he thought they might fairly ask and receive some of the sympathy and consideration which the Corporation had extended to the gas company for so many years.

The motion was carried unanimously, and the proceedings terminated.

The Direct Spanish Telegraph Company (Limited).

The following is the report of the Directors for the half-year ended December 31st last, to be presented to the general meeting of shareholders, to be held on Monday, the 24th inst.:—

1. The accounts for the half-year ended December 31st, 1889, show, after providing for Debenture interest, a balance to the credit of profit and loss of £6,361. 2s. 7d.

2. The traffic receipts are in excess of those for any previous half-year, and show an increase of £1,592. 2s. 6d. as compared with the corresponding half-year of 1888.

3. The working expenses are £690. 10s. 4d. in excess of those for the corresponding period of last year.

4. The Company's cables and the land lines in connection with them have continued in good working order throughout the half-year.

5. Owing to the increase of the Company's business it became indispensable to remove the London telegraph station to more suitable and extensive premises. The Directors have therefore taken on lease No. 74, Gracechurch-street, which has been fitted up so as to meet the development of the traffic, and which was opened for business on July 20th last.

6. Of the balance of profit and loss £2,500 have been put to the reserve fund, which now amounts to £17,515. 19s. 8d., and there remains an available balance of £3,861. 2s. 7d. Out of this amount the Directors recommend the payment of the dividend at the rate of 10 per cent. per annum on the Preference shares, and a dividend at the rate of 6 per cent. per annum (free of income-tax) on the Ordinary shares, making, with the previous distribution, 5½ per cent. for the year 1889, against 4½ per cent. in 1888. This will admit of a sum of £846. 18s. 2d. being brought forward to meet possible contingencies.

7. Mr. Edmund Etlinger and Mr. John Denison Pender are the Directors retiring by rotation, and offer themselves for re-election, The auditor, Mr. Herbert R. Duke, retires, and offers himself for re-election.

The dividend warrants will be issued on April 1, 1890.

NEW COMPANIES REGISTERED.

KEY'S ELECTRIC COMPANY.—Objects: To carry on the business of electrical engineers, mechanical engineers, and manufacturers of and dealers in all apparatus required in connection with the employment of electricity for any purpose. Capital, £15,600, in 3,000 ordinary shares of £5 each, and 600 Founders' shares of £1 each. Of the ordinary shares, 1,500 shall be allotted to John Henry Ward or his nominees, and the remaining 1,500 to Franz Deutsch or his nominees. Of the Founders' shares, 450 shall forthwith be paid up in full in cash. No remuneration to be paid out of assets except for extra special service. Borrowing powers are not restricted. Registered, March 7th, by Tamplin, Taylor, and Joseph, solicitors, 165, Fenchurch-street.

MACMAHON'S PATENT ELECTRIC CHECK SYSTEM.—Objects: To carry on the trade of manufacturers of and dealers in automatic or other machines, instruments, and apparatus of all kinds, adopting therefor an agreement of March 6, 1890, made with Francis Edward Macmahon and Charles Hitchen Ashley, the particulars of which are not specified in the Articles of Association. Capital, £30,000, in £10 shares. First Directors (three to five) Charles Hitchen Ashley, Henry Burt, and Francis Edward Macmahon, holding office until 1893, and their appointees prior to ordinary meeting in 1890. Qualification, £1,000, in shares or stock. Remuneration, £100 per annum each, divisible, however, in proportions to be determined. Borrowing powers are not restricted. Registered, March 6, by Gush, Phillips, Walters, and Williams, solicitors, 3, Finsbury-circus.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The Directors of this Company have declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, free of income tax, for the quarter ended December 31, 1889, and payable on the 25th inst. The books of this Company will be closed from the 18th to 24th inst., both days inclusive. The traffic receipts of the Company for the week ended March 7th amounted to £5,060.

EVERED AND CO. (LIMITED).—This well-known firm of electrical and general fittings manufacturers announce the issue of debentures for £50,000, carrying interest at the rate of 5 per cent. per annum, which will be issued in amounts of £50 and £100, payment to be made in full on allotment. The prospectus states that the issue is made for the purpose of further extending the already large works at Smethwick and in Birmingham. These debentures will form a first charge as a floating security upon all the real and personal property, assets, and effects of the Company (except the uncalled capital). The last balance-sheet of the Company, certified by Messrs. Chatteris, Nichols, and Atkins, shows the assets to exceed £180,000, exclusive of goodwill. Since its formation the Company has paid regular dividends at the rate of 7½ per cent. per annum, and there is a reserve fund of £10,000. The Company's bankers are the London and Westminster Bank (Bloomsbury Branch) and the National Provincial Bank of Birmingham, of whom, and of the Company, forms of application for this new issue of debentures may be obtained.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic returns of this Company for the month of February amounted to £19,800. From the 1st January to 28th February these receipts amounted to £39,400, against, in the corresponding months of 1888 and 1889, £41,800 and £42,000 respectively.

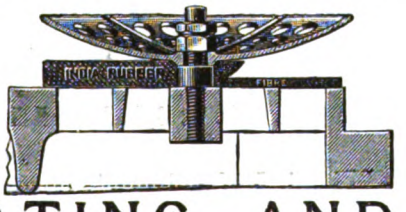
STOCK EXCHANGE.—Application has been made to the Committee to appoint a settling day in and to grant a quotation to the Westminster Electric Supply Corporation, Limited—ordinary shares; and United River Plate Telephone Company, Limited—£146,128 Five per Cent. Debenture Stock.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended March 7th, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,896.

WESTERN UNION TELEGRAPH COMPANY.—This Company has declared a quarterly dividend of 1¼ per cent.

NEW VALVE

No Rubber, Percha, or Leather.



One-half the price of Rubber or Metal.

FOR CIRCULATING AND AIR PUMPS.

Unaffected by any Lubricating Oils. Does not Expand in diameter. Feed Water may be worked at any temperature
Suitable for any shaped guards. Only one quality manufactured.

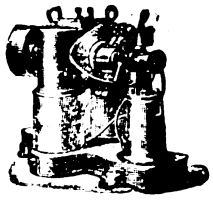
"12, John-street, Sunderland, 26th Sept. 1885.
"DEAR SIRS,—In reply to your letter of the 25th inst., the Valves I got from you have done their work well, and ARE AN UNQUALIFIED SUCCESS. I will continue get them from you as required.—Yours faithfully, JAMES WESTOLL."

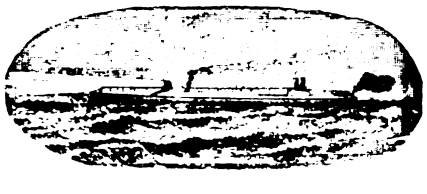
For further Testimony and Prices, apply to MOSSES & MITCHELL, 68-71, Chiswell Street, London.

Digitized by Google

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Wednesday, March 12, 1890	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending March 12, 1890.	
£			**TELEGRAPHS.**		£ s. d.		Highest.	Lowest.
1,770,360	Stock	15/0	Anglo-American	49 50	5 10 0	Jan., Apr., July, Oct.	49½	48½
2,614,820	Stock	30/0	Do. Preferred	83 84	6 10 11	,, ,,	84	82½
2,614,820	Stock	...	Do. Deferred	14½ 15	...	February	14⅞	14⅛
130,000	£10	3/0	Brazilian Submarine	12½ 13	5 15 5	Mar., June, Oct., Dec.	12⅛	...
112,900	£100	5%	Do. 5 per Cent. Bonds	100 102	4 18 0	January and July	...	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	104 107	4 13 6	June and December.	...	...
16,000	10	9/0	Cuba Submarine	11½ 11¾	7 13 3	February and August	11⅛	11½
6,000	10	10%	Do. Preference 10%	17½ 18½	5 8 1	,, ,,	18	17½
12,931	5	2/0	Direct Spanish (£4 paid)	4 4½	4 8 11	March & September	...	...
6,000	5	10%	Do. Preference 10%	9 10	5 0 0	April and October	...	...
60,710	20	3/6	Direct United States	10 10½	6 19 4	Jan., Apr., July, Oct.	10¼	...
280,000	10	2/6	Eastern	13⅞ 14⅛	4 12 0	,, ,,	14⅛	14
70,000	10	6%	Do. 6 per Cent. Preference	14¼ 15½	3 18 8	,, ,,	15	14½
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock	105 107	3 14 9	May and November.	106¾	106½
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	106 109	4 11 9	February & August	...	...
250,000	10	2/6	Eastern Extension	13¾ 14	4 12 10	Jan., Apr., July, Oct.	14	13⅞
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	100 102	5 17 8	February & August	...	...
473,000	100	5%	Do. 5 per Ct. (Austrln. Gov. Sub.) Debs. 1900	102 105	4 15 3	January and July	...	...
179,177	10	1/9	Globe Telegraph and Trust	8⅛ 8¾	6 2 10	Jan., Apr., July, Oct.	8¾	8⅝
178,992	10	6%	Do. 6 per Cent. Preference	14½ 14¾	4 1 4	,, ,,	14⅛	14½
150,000	10	5/0	Great Northern	15¾ 15⅞	4 15 3	Jan., July, and April	15⅞	...
17,000	25	12/6	Indo-European	41 43	5 16 3	April and October	42¼	...
9,000	8	4/0	Reuter's	7 7½	5 6 5	April and October	...	...
15,609	10	3/6	West African Telegraph	9½ 10½	...	...	...	...
300,000	100	5%	Do. 5 per Cent. Debentures	97 100	5 0 0	March & September	99½	97½
30,000	10	5/0	West Coast of America	10½ 11	4 10 11	January and July	10⅝	...
150,000	100	8%	Do. Debentures 8%	119 124	6 9 1	June and December	123½	...
88,321	10	nil.	West India and Panama	3⅜ 3⅝	...	...	3⅞	3⅛
34,563	10	12/0	Do. 1st Preference 6%	11½ 12	...	April and October	12⅛	11½
4,669	10	10/0	Do. 6 per Cent. 2nd Preference	15 16	3 15 0	...	...	...
45,181	15	6/0	Western Brazilian	10¼ 10⅜	6 19 8	May & November	10½	10¼
$1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	118 122	5 14 9	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	99 101	5 18 10	March & September	...	...
			TELEPHONES.					
224,850	14/0	5%	Consolidated Telephone and Maintenance	⅛ ⅛	5 12 0	Yearly	...	...
220,000	£1	3%	Oriental (11s. paid)	⅛ ⅛	3 5 11	...	⅜	...
80,000	5	3/0	National	5⅛ 5⅜	...	June and December.	5⅜	5⅛
55,000	5	2/0	United River Plate	4¾ 5¼	...	January and July	5¼	...
			ELECTRIC LIGHT.					
500,000	10	...	Metropolitan Electric Supply (£5 paid)	5¾ 6¼	...	...	5¾	5⅞
79,934	5	6%	Swan United (£3. 10s. paid)	4¾ 5¼	4 0 0	...	5⅛	4⅞
			MISCELLANEOUS.					
37,350	12	12/0	Telegraph Construction and Maintenance	44 46	5 2 7	March and July	45½	44½
41,600	10	10/0	India Rubber, Gutta Percha & Telegraph Works	17½ 18½	5 8 1	February & August	18⅜	17¼





Before Ordering!

ELECTRICAL PLANT & ACCESSORIES

(Statter's) WRITE FOR THE FOLLOWING PAMPHLETS TO THE (United)

ELECTRICAL ENGINEERING CORPORATION, Ld.

PLANT WORKS: WEST DRAYTON, near LONDON.
FITTINGS WORKS: ALBERT WORKS, 36, ALBERT EMBANKMENT, S.E.
LONDON OFFICES: 3, PRINCES MANSIONS, VICTORIA STREET, WESTMINSTER.

"ELECTRICAL DISTRIBUTION."—Commercially considered, with Estimates.

"MACHINE DRIVING BY ELECTRICITY."—The Uses of Electro-Motors for Traction and Stationary Purposes.

"THE TELPHER SYSTEM OF CHEAP TRANSPORT," for Minerals, Goods and Passengers.

"ELECTRICAL SUPPLIES."—Prices and Particulars of the most approved Electrical Appliances.

ELECTRICAL PLANT ON VIEW.

Digitized by Google

THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 618.—Vol. XXIV. FRIDAY, MARCH 21, 1890. Price Fourpence.

NOTES.

An Edison "fundamental" patent of considerable importance has just been sprung upon the electrical industry on the other side of the Atlantic. At the beginning of the present month the Edison Electric Light Company commenced an action against one of the companies controlled by the Westinghouse Company for the infringement of Edison's electromotor meter patent of 1881. This patent lays claim to "the combination with an electric circuit, containing translating devices, of an electric motor having a definite loading and apparatus for registering the work done." The motor, it is further stated, may be provided with fans, and the fans may be placed in a vessel filled with liquid. The apparatus which, it is alleged, infringes this patent is the ingenious alternate-current "induction" meter due to Mr. Shallenberger.

The rush for Provisional Orders which we witnessed last summer, and which in a somewhat more moderate form we are probably destined to witness again this year, undoubtedly placed local authorities in a decidedly awkward position. Their natural sense of justice, and, we may add, the Board of Trade regulations, prevented local bodies from assuming a purely negative attitude with regard to the electric light. On the other hand, their suspicion of the capabilities of the intending illuminant and of the financial soundness of many of its sponsors, together with a not unnatural doubt as to whether electricity would pay, did not tend to make Town Councils, Local Boards, and Vestries very favourably disposed towards the erection of central lighting stations, whether municipal or private.

Having admitted, however, that the question is one of considerable difficulty, it might well be asked, what do local authorities exist for, if not to solve fairly and squarely, and in the best interests of the ratepayers the various knotty problems relating to municipal matters which arise from time to time? Now, for local bodies to obtain electric lighting Orders, and then to pass on the powers so obtained to the first comer and divest themselves of all further legal responsibility, is hardly a fair and square solution of the difficulty, nor will it in the long run be to the best interests of the ratepayers. But such, apparently, is the policy which, as will be seen in our Notes column, the Association of Municipal Corporations have urged the Board of Trade to accede to, and which we are glad to see that this Department has firmly declined to countenance. So long as the Board of Trade only gives preference to the applications of local bodies when these local bodies are prepared to undertake the supply of electricity on identically the same terms as ordinary companies, the electrical industry will have no reason to complain; but it would be manifestly unfair to grant privileges denied to joint-stock companies to local authorities engaged in joint-stock enterprises.

The adverse decision recently delivered at Cincinnati by Judge Taft in regard to the use of the single trolley system has been quickly followed by one in its favour. At Albany (N.Y.), where an action was brought by the Hudson River Telephone Company against the Watervliet Turnpike and Railway Company, the judges have decided that the telephone company must "metallicise" its circuits, and have left open for future consideration the question of which party shall bear the expense of this operation. Considering that entirely apart from the disturbances due to the existence of electric railways, the telephone system of any large town would undoubtedly be greatly improved by the adoption of complete metallic circuits, it does not seem to us that in equity any part of the expense of providing an efficient telephone service should be borne by the traction companies. In view, however, of the expenses and uncertainty of the law, it may be anticipated that an amicable compromise on this point will soon be arrived at across the Atlantic.

At the recent Convention of the National Electric Light Association, Mr. Talmage exhibited a novel and ingenious form of electric heater, consisting of a special variety of transformer. It is composed of a straight laminated iron core, around which the primary coil is wound. The solenoid thus formed is completely surrounded by a single turn of very thin sheet-metal, forming a short-circuited secondary circuit. Nearly all the energy supplied electrically to the primary is transformed directly into heat in this thin cylindrical tube, the large surface of which is sufficient to ensure rapid radiation. Heating within the cylinder is avoided as much as possible by using laminated iron cores and employing thick primary wire, although, of course, all the heat there produced is utilised, the efficiency of this kind of converter being necessarily 100 per cent. The heaters exhibited by Mr. Talmage took 100 volts and about 6 amperes in the primary circuit, and developed about 3,000 amperes in the secondary. The temperature attained by the cylindrical sheet is, unfortunately, not mentioned. The only doubtful part of the

Digitized by Google

invention arises from the fact that the insulation of the primary coil must suffer from the high temperature to which it is necessarily subjected, unless the radiating surface of the secondary circuit is very large.

In the current number of *La Lumière Electrique* is described a new method of fixing iron filing-curves, due to M. Korobow. The usual method of fixture, on a plate of glass covered with gum by passing a jet of vapour over the surface, is objected to on account of needless cost and the unsatisfactory nature of the results obtained. The photographic method is, moreover, difficult, and only possible to a comparatively few. M. Mach's process consists in mixing iron filings with aniline powder and spreading over the surface. The figure is formed in the usual way, the iron filings are removed by means of a magnet, and the aniline remains fixed to the paper. The figures obtained are, however, seldom sharply defined. In M. Korobow's process a plate of glass is warmed on the smooth upper surface of a shallow iron chest containing water raised to a suitable temperature by means of a spirit lamp. A piece of paraffin is placed on the glass, and in the course of three or four minutes spreads itself evenly in a thin layer over the surface. The glass plate is removed, the surplus paraffin running off. The image is formed with iron filings on the cooled paraffin, which does not adhere to the iron; so that, if the image is unsatisfactory, the filings may be removed and a new figure taken. To fix the curves, the plate of glass is again placed on the warming stove. Finally, the surface of the paraffin is covered with white paint, so that the curves appear black on a white ground. Very well-defined figures may thus be obtained. A similar though much simpler process consists in covering one surface of stiff white paper with a layer of paraffin, by warming over an iron plate, spreading the filings over the cooled surface, and fixing them with a hot iron or a gas flame.

When Sir William Thomson is led into error he always finds it out himself before anyone else suspects it. These occasions are, however, so rare that they deserve to be recorded. In a note communicated to the *Phil. Mag.* he has endeavoured to show that the quantities of electricity induced in the secondary by the starting and stopping of a current in the primary are not always equal, as is usually supposed. The inductor current on make is generally less sudden than that on break; so that, if the currents do not distribute themselves evenly throughout the conductor, the effective resistance of the secondary is less to the current induced by the make than to that induced by the break. As the quantity induced is inversely as the resistance of the secondary circuit it would therefore appear that the two induced quantities would differ. The reasoning employed would convince nearly every reader; but Sir William Thomson, in the foot-notes, shows that the argument is all wrong, and that the common belief that the two induced quantities are equal is quite correct.

A most striking example of the skin resistance of conductors for alternating currents has recently been noticed by Lord Armstrong, and will be found described in our Notes column. A bar of steel, held in the hand, was accidentally allowed to short-circuit for a moment an alternating current dynamo. The surface of the bar immediately became so hot as to blister the fingers. The heating, however, only occurred at the surface, for the bar just afterwards was found to be quite cold.

Up to the time of going to press our New York letter had not reached us.

Drogheda.—The Corporation, at their last monthly meeting, decided to apply for a Provisional Order.

Belfast.—At the last meeting of the Corporation it was unanimously decided to apply for an electric Lighting Provisional Order.

Académie des Sciences.—At the last meeting of the Académie des Sciences, Lord Rayleigh was elected correspondent to the Physical Section.

Brunn.—The firm of Bartelmus and Co. intend to erect a central station on the Doubrava system (*Electrician*, April 19, 1889, and July 26, 1889).

Madrid.—It is announced by *El Telegraphista Espagnol* that Dr. Celestino Goni and the Director of Telegraphs have founded an electrical engineering college at Madrid.

An Electrical Bakery.—The new premises of Mr. W. Beale, confectioner, in the Holloway-road, London, N., are lighted throughout by electricity. There is also an electrical bakery.

Hong Kong.—The enterprising Californian Chinamen who are about to introduce the electric light into Canton are now considering the advisability of trying to get a long-term franchise to light Hong Kong.

The International Telegraph Congress.—In the Chamber on Thursday last week the Minister of Commerce asked for a vote of 100,000fr. for the International Telegraphic Congress to be held at the Louvre next June.

The Strand Electric Lighting Order.—The Board of Trade has intimated to the Strand District Board of Works that the Strand Electric Lighting Order, against which the Board petitioned, will not be proceeded with any further.

Obituary.—We regret to record the death on the 18th inst., at Seaton, Devon, after a long illness, of Captain Alfred P. Briscoe, who formerly, in the service of the Eastern Telegraph Company, commanded the cable ships "Hawk" and "Chiltern."

Mr. Edison and Mining Investigations.—Mr. Edison, says the *Financial News*, has taken quarters in Charlotte, North Carolina, for himself and assistants. For the next year they will pursue their investigations in the mining districts of the State.

Telegraph Extensions on the North-West Frontier.—A telegraph line is to be constructed between Quetta and Apozai, the head-quarters of the new Zhob Valley district, and in time there will be direct communication between Dera Ismail Khan and Apozai through the Gomal Pass.

Chemical Society.—The anniversary meeting of this society will be held this year on Thursday, March 27th, at 4 p.m. The members and their friends will dine together at the Whitehall Rooms, Hotel Métropole, on the evening of the same day, at seven for half-past seven o'clock.

City of London and Southwark Subway.—Sir Edward Watkin, Mr. Barratt, Mr. Bell, Mr. Perks, and other members of the Metropolitan Railway, visited the works of the City of London and Southwark Subway on Friday last, and expressed themselves pleased with the working of the electric locomotive.

Islington.—At the last meeting of this Vestry the committee's recommendation that the formal consent of the Vestry should be given to the House-to-House Company's Provisional Order, was agreed to, it being at the same time resolved not to approve for the present of the Order promoted by the Brush Electrical Engineering Company.

The Inventor of the Cowles' Process.—We are informed that Mr. Alfred Cowles, whose death was recently reported from Chicago, was a prominent newspaper man in that city, and was the uncle of Mr. Alfred Hutchinson Cowles, one of the inventors of the Cowles' process. The latter gentleman, we are pleased to hear, is in good health.

Digitized by Google

Bath.—Mr. Massingham has been granted an extension of time to June 24th before commencing the electric lighting of the streets. Under the contract with the Corporation the lighting should have been started on the 25th inst. The reason for the delay is said to be the difficulty which has arisen in connection with the laying of the underground mains.

Philosophical Society of Glasgow.—A lecture on "Public Lighting by Electricity" was delivered on Wednesday night under the auspices of this Society by Mr. Henry A. Mavor, in the banqueting hall of the City Chambers, Glasgow. Prof. M'Kendrick presided, and Sir William Thomson was amongst those present. At the close of the lecture Mr. Mavor was accorded a vote of thanks.

New Telegraph Wire to London.—The erection of a new telegraph wire between Aberdeen and London has just been sanctioned by the Post Office authorities. At present there are two duplex Wheatstone circuits for private messages from London to Aberdeen, and two wires devoted exclusively to the transmission of news. The new wire is to be used for private messages, and will be fitted up as a duplex Wheatstone circuit.

Telegraphic Communication between India and China.—There is every probability, says *Indian Engineering*, that in the future a through land line of telegraph from India and China will be opened. Our wires now stretch as far eastwards as Bhamo, and the China Government some time ago had extended their western lines as far as Yung Chang, 30 miles east of Momein in the Yunan Province, and not more than 130 miles from the north-eastern frontier of Upper Burma.

Frankfort-on-the-Main.—Herr von Müller, of Munich, formerly manager of the "Allgemeine Elektrizitäts-Gesellschaft" of Berlin, has been chosen to superintend the work connected with the International Electrical Exhibition to be held in this city in 1891. Herr von Müller, who took a leading part in the Munich Electrical Exhibition of 1882, contributing not a little to its success, will shortly make a tour of Europe in order to personally promote the interests of the undertaking.

Port Said.—A telephone exchange was opened at this place on January 28th last by the Telephone Company of Egypt (Limited), and the chief firms and shipping companies have already given their support to the undertaking, Permission has been granted by the Suez Canal Company for a cable to be laid beneath the canal, and those firms and others having establishments on the East Bank will shortly be placed in direct communication with the Central Office, situate in the Boulevard du Port.

The Telegraph and Telephone in Chili.—In a report from Santiago just issued by the Foreign Office, the British Minister states that, besides State lines, private lines are developing considerably in Chili. The interior of the country is crossed in all directions with a vast network of telegraphic wires. Telephonic communication connects the different suburbs to the principal towns, and even the near villages, and is especially used for communication between offices, factories, and warehouses, and for police service.

Interesting Presentation.—An interesting ceremony took place at the Reindeer Hotel, Newcastle-on-Tyne, on Saturday, March 8th. Mr. J. G. Moon having resigned his appointment of works manager to Messrs. J. H. Holmes and Co., electric light engineers, of that city, the *employés* of the firm, to show their esteem and regret at his leaving, presented him with a very handsome ormolu clock and vases, value £20. We understand that Mr. Moon has accepted the position of works manager to Messrs. J. G. Statter and Co., of West Drayton.

Country House Lighting.—One of the most successful installations of the electric light for private purposes yet carried out in Ireland is that just completed at Grove House, in the county Tipperary, the residence of Mr. R. Burke, Master of the Tipperary Fox Hounds; where the out-offices, stables, and kennels are lighted by electricity, as well as the house itself. This installation was carried out to the specification and under the immediate superintendence of Messrs. J. K. Fahie and Son, of Dublin. Accumulators charged by an Elwell-Parker dynamo are employed.

Telegraphs in Brazil.—There is a prospect that the Brazilian Telegraph Department will shortly be located in truly palatial premises. The central station in Rio have been found exceedingly inconvenient, and the last mail advices report that the Minister of Agriculture had asked the Department of the Interior for permission to have the City Palace for the headquarters of the Telegraph Department. According to the *Rio News* of February 17th, it was expected that the Director-General of Telegraphs will shortly announce a reduction of 20 per cent. in the ordinary rates and of 50 per cent. in the rates charged to the press.

Accident to the Electric Light at a Theatre.—A panic occurred at the Volks Theatre at Vienna on Saturday last, owing to the melting of the insulation of some of the electric light wires. As soon as the molten drops began to fall on the stage the occupants of the stalls started from their seats, but order was restored for a while by the presence of mind of an actor, who went on with his part. Presently, however, a fireman blew a shrill fire signal, which proved too much for the nerves of the audience, and there was a general stampede. Fortunately no one was hurt. It is to be hoped that those responsible will now look to their fuses.

Aden.—On the 7th inst. a severe rainstorm, lasting over three hours, visited Aden, and in less than an hour all the Government tanks, with a total capacity of eight million gallons, were filled and overflowed to the sea in a destructive torrent. All the roofs of the Eastern Telegraph Company's station leaked, and the instrument room suffered terribly. The wires and instruments were all wet and all the circuits were in contact, and it was found necessary to run new temporary connections. On the 14th Aden was visited by another tremendous rainstorm, accompanied by much thunder and lightning. On the 15th there were again heavy showers of rain. While the lightning lasted all the cables were put to earth.

English Telegraphists in Persia.—In the concluding letter of a long and interesting series on "Persia and the Persian Question," which has recently been appearing in *The Times*, the writer remarks: "For 26 years a telegraphic department, with a staff of 40 English officials, working a single wire between Meshed and Teheran, a triple wire between Teheran and Bushire, and a duplicate cable along the shores of the Persian Gulf, has been in existence in that country. It is among the most agreeable incidents of travel upon any of these lines to come at intervals of 60 or more miles upon the telegraph station, occupied by an English official, who dispenses a generous hospitality, and, as a rule, is excellently informed about the country in which he has lived and worked so long."

The Lighting of the City.—At the last meeting of the Commissioners of Sewers a report of the Streets Committee relative to the proposed contracts with the Brush Electrical Engineering Company and the Laing, Wharton, and Down Construction Syndicate was considered with closed doors. The *City Press* remarks in this connection:—"It is almost incredible that even yet the exact form of the contract for electric lighting in the City has not been definitely settled by the Sewers. It is said that clauses have been inserted which will be enforced upon the companies, under the threat of opposing their applications for Provisional Orders. The persistent opposition of a section of the Commissioners of Sewers may possibly run the City into great difficulty and expense; for when the Provisional Orders are obtained the companies are not likely to undertake street lighting on the terms proposed."

Municipal Authorities and Electric Lighting Orders.—In accordance with the resolution passed by the Association of Municipal Corporations, the Town Clerk of Hull and Mr. A. Goring Pritchard, the secretary, visited the Board of Trade last week to arrange for a deputation to the President on the subject of inserting powers in electric lighting Provisional Orders enabling local authorities to transfer their undertakings or delegate their powers to companies. They discussed the question with Mr. Calcraft, the secretary of the Board, and he agreed to amend the Model Order so as to enable local authorities to delegate their powers to companies, but at the same time he declined to divest the local authority of all responsibility. The Model Order will accordingly be revised, and Mr. Calcraft has promised, if it be thought advisable, to arrange for a deputation to see the President on the subject.

Digitized by Google

Technical Instruction.—The object of the Bill introduced by Sir Henry Roscoe, M.P., is stated as being to clear up any doubt as to the legality of the provision of technical and manual instruction in public elementary schools. At present it is questionable whether the managers of these schools may include such instruction in the time-tables, so that attendance at it may be counted as attendance at school. The effect of the Bill will be to remove all doubts on these points. It declares that the managers of any public elementary school may provide technical or manual instruction for the scholars either on the school premises or in any other place approved by the inspector; and attendance at such instruction is to be deemed to be attendance at the public elementary school. The condition on which Parliamentary grants are to be made in aid of technical or manual instruction in public elementary schools are to be those contained in the minutes of the Education Department and of the Science and Art Department in force for the time being.

Glasgow.—Reports with regard to an accident to a fireman which recently occurred at the premises of Messrs. R. Sorley and Son, jewellers, have been laid before the Corporation. Captain Paterson, inspector of fires, states that while attending a fire in Messrs. Sorley's shop, John M'Gregor, fireman, received a severe electrical shock which necessitated his being off duty for eight days. Mr. Cook, electrician, reports that the fire, and the accident to the fireman, were both due to leakage of the high potential electricity, and that the leakage was caused by the men on the job scamping their work at a place where it was exceedingly difficult of detection. Moreover, the faulty conductors were arranged in contravention of rules issued by the Institution of Electrical Engineers and the Insurance Companies for the prevention of fires. With these exceptions, all the work was well executed, the overhead arrangements conforming fully with the Board of Trade regulations. The Council resolved to forward copies of the reports to the Board of Trade, and direct their attention to the subject.

Electric Bills in Parliament.—The Canterbury Gas and Water Bill came before a Select Committee of the House of Commons on Wednesday. One of the clauses in the Bill proposed to authorise the Company to spend money in going before the Board of Trade to apply for an Electric Lighting Provisional Order. Mr. Harry E. Jones, C.E., the engineer to the Commercial Gas Company, in giving evidence for the promoters, said that if anyone were to give a supply of electricity to the city, no doubt the Gas Company would be able to do it better than strangers. That was also the view, he knew, of electricians, because he had been approached over and over again, owing to his connection with one of the London gas companies, to see whether he could not adopt some method of working with them. He thought electric lighting companies had taken the cream of the lighting from the gas companies. He did not think the two lights competed for general purposes, but only where expenditure was not considered, such as restaurants, hotels, and clubs. He thought, taking London, that electric lighting would be very likely to develope if the gas companies had the right of supply. The Committee were unanimous in saying that it was better to eliminate the electricity clause altogether.

The Resistance of Conductors to Transient Currents.—At the last meeting of the Royal Society of Edinburgh, Sir William Thomson read a Paper recounting an accidental illustration of the effective ohmic resistance to a transient electric current through a steel bar. He said that at the recent meeting of the British Association at Newcastle Lord Armstrong had told him of an interesting incident. A bar of steel about a foot long, which he (Lord Armstrong) was holding in his hand, was allowed accidentally to come in contact with the two terminals of a dynamo. He instantly felt a painful sensation of burning, and he let the bar drop. He found his fingers where they had been in contact with the bar severely blistered. The bar was found immediately afterwards to be quite cold. This proved the outer surface of the steel to have been intensely heated, and that not enough of heat was generated to sensibly warm the whole bar. Lord Armstrong had sent him the bar and some further details. There were two hollows burned out of the metal at the points where the bar touched the terminals of the dynamo. Lord Armstrong had held the bar midway between the two marks. It was perfectly cold three or four seconds after he dropped it. The dynamo gave an alternate-current of 85 amperes, at a difference of potential of 103 volts. Sir William Thomson then showed how the theory involved could be worked out by Maxwell's fundamental equations of electromagnetism. He discussed the theory at some length, and showed that there was a thermal analogy.

Electric Lighting in Japan.—The following is a list of the Electric Light Companies actually in operation in Japan, with the capacity of the various stations and the number of lamps actually in use:—

Companies.	Lamp capacity.	Lamps in use.
Tokio Electric Light Company	12,800	7,500
Kyoto Electric Light Company	2,200	900
Kobe Electric Light Company	2,200	1,000
Osaka Electric Light Company	3,500	900
Nagoya Electric Light Company ...	1,600	700
Total	22,300	11,000

In addition, the following companies have received Government sanction for supplying the annexed number of lights:—

	Lights.
Nagano Electric Light Company	1,000
Kumamoto Electric Light Company	1,000
Nagasaki Electric Light Company	1,000
Hakata Electric Light Company	1,000
Yokohama Electric Light Company	5,000
Hiroshima Electric Light Company.....	1,200
Shidsuoka Electric Light Company.....	1,500
Hokkaido Electric Light Company	2,600
Hakodate Electric Light Company	1,000
Niigata Electric Light Company	1,500
	16,800

The first company to begin operations was the Tokio Electric Light Company, which started in 1886. The extent to which the electric light has been adopted in the Japanese cotton mills is a very remarkable feature of this rapid development of electric lighting.

Dry Batteries for Telephone Work.—Within the last few years a number of dry batteries have made their appearance in America, some of which have met with not a little success, and have been tried to a considerable extent by the telephone companies especially, who find the care which their batteries require to be a considerable item of expense. In discussing the question relative to the advantages and disadvantages of the dry battery over the ordinary fluid cell, Mr. John A. Barrett, without referring to any particular form of dry battery, shows, in a recent article, that, all things being taken into consideration, the dry battery can never compete with the fluid cell for the usual run of work. As he puts it, the amount of water which any cell will contain stands almost alone and independent of the size and form of the electrodes as the limiting measure of the ultimate life of the battery at any work for which it is fitted. The size and form and quality of the electrodes affect the temporary constancy of the cell, but the question whether, in any specified service for which the cell is adapted, it will continue active for one month, or six months, or a year, is answered almost exclusively by the measured quantity of water which the cell is made to contain. Hence, he argues that the life of a dry battery must in any case be inferior to that of the fluid cell. Besides, in the usual form of dry battery when the cell is worked out, it is practically useless for any other purpose, and practically none of its parts can be used over again; whereas in the fluid cells, such as the Leclanché, the zinc may be replaced and the porous cell renewed at a comparatively slight cost. Mr. Barrett points out also that water in a cell is necessary to dissolve the salts formed by the deposition of the zinc, which, if they do not go into solution, soon increase the internal resistance of the dry cell to such a point as to make the cell useless for any practical purpose. As a remedy for exhausted cells of this nature Mr. Barrett suggests washing the porous cup and its contents in dilute muriatic acid. Taking all of this into consideration, Mr. Barrett concludes that except in special situations, such as on board ship or railway trains, where cells have to be shipped a great distance and placed in ignorant hands, the dry battery cannot compete with the fluid cell.

Digitized by Google

MAGNETISM IN IRON AND OTHER METALS.*—X.

BY PROF. J. A. EWING, F.R.S.

(*Continued from page 468.*)

§ 50. **Supplementary Remarks on the Magnetometric Method.** In testing the magnetisation of soft iron, especially if the specimen is at all thick—it will be found necessary to pause after each increase in the magnetising current, and to keep the current constant for some seconds, or even minutes, before the iron takes its full magnetisation. The "creeping up" of the magnetometer deflection which takes place after each increase of magnetising force will be spoken of more fully in a later chapter.

If the specimen is placed rather near the magnetometer and the deflection threatens to become greater than the scale will measure, the magnetometer needle may be brought back towards its undeflected position by using a permanent magnet (a hard steel wire will do well) to counterbalance a part of the the deflecting force exerted by the specimen under examination. This compensating magnet must be placed so that it exerts no force at the magnetometer except in the direction exactly opposite to that of the force the specimen exerts. In other words, it must exert deflecting force, not directing force (§ 39), and to secure this it should be placed before or between the magnetometer (pointing towards it) in the line B A C of Fig. 18. When the compensating magnet is introduced, the number of scale divisions through which it causes the needle to return is to be noted, and this is to be added to subsequent scale readings in reckoning the virtual deflection. The compensating magnet is specially convenient when we wish to examine the effect of applying or removing a small amount of magnetic force when the specimen is already somewhat strongly magnetised.

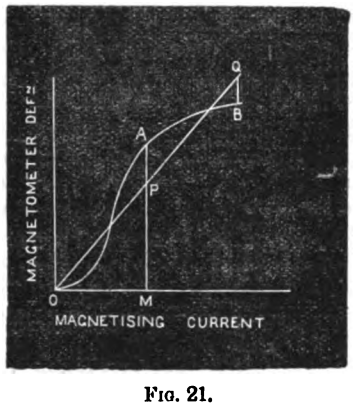


FIG. 21.

A useful method of getting increased sensibility is to use a compensating coil (§ 41) to balance a part (or even the whole) of the deflection produced by the magnetisation of the specimen itself. Suppose, for instance, that it is desired to examine particularly the form of the magnetisation curve under moderately weak magnetic forces—say the part O A B of the curve (Fig. 21)—we may set the specimen near the magnetometer, and at the same time advance the compensating coil so that it counterbalances a large part of the deflection. Thus, let P M be the part of the deflection balanced by the coil, when the magnetising current is O M: the whole virtual deflection is got by adding this to P A, which is the observed deflection. For any stronger or weaker current the part balanced is represented by the corresponding ordinate of the straight line O P Q. The slope of this line is found by observing the deflection given by the coil and solenoid when the specimen is taken out and a known current is applied. When the specimen is put in and the process of magnetisation is gone through, the actual deflections of the magnetometer are, of course, limited to the (positive or negative) portions of the ordinates intercepted between the straight line O Q and the curve. By adjusting the position of the coil so that O Q is nowhere far from the curve a high degree of sensibility becomes possible, for the whole range of the magnetometer scale may then be used in exhibiting the differences P A, Q B, &c. This method should be specially serviceable in dealing with ellipsoidal specimens of moderate elongation.

* All rights are reserved.

§ 51. **The Ballistic Method.**—The ballistic method, briefly alluded to in § 38, was invented by Weber, was used by Thalen, Stoletow, Rowland and others, and received its name from Sir William Thomson.* It determines any sudden change of magnetic induction by measuring the quantity of electricity in the transient current which is induced in a coil wound over the magnetised piece. Let a coil, which for brevity we may call the secondary coil, be wound on the bar or ring or other specimen which is to be magnetised. The coil need not extend over the whole length of the specimen, and in the case of a bar a short coil is best, wound over the central part only, where the magnetisation is most nearly uniform. The coil is to be put in circuit with a galvanometer, the needle of which has a considerable moment of inertia (in relation to the directive force acting on it), so that it swings slowly. An ordinary mirror galvanometer is easily adapted to serve as a ballistic galvanometer by fixing a small weight to the mirror. If the specimen is wound with a magnetising solenoid sudden changes of its magnetism may be produced by applying a magnetising current, by increasing it by steps, by reversing it, and so on; and each of these will cause a "throw," or impulsive deflection of the ballistic needle, which will be proportional to the whole change of magnetic induction within the secondary coil. The "throw" is proportional to the whole quantity of electricity which passes in the transient current, and this in its turn is proportional to the change of magnetic induction within the coil. Let Q be the total number of lines of magnetic induction within the secondary coil, and ΔQ any sudden change which this number undergoes. Let N_2 be the number of turns in the secondary coil, and R_2 the whole resistance of the secondary circuit (in ohms), including, of course, the resistance of the ballistic galvanometer. Then the whole quantity of electricity in the corresponding transient current is

$$\frac{N_2 \Delta Q}{R_2}.$$

The observed throw of the galvanometer measures this, and the simplest way to calculate ΔQ from it is to compare this throw with that which occurs when the number of lines of induction within a coil in the secondary circuit is changed by a known amount. In other words, we may standardise the ballistic galvanometer by finding what throw a known change of induction causes.

§ 52. **Earth Coil.**—Suppose, for instance, that there is included in the secondary circuit another coil, consisting of a number of turns of wire wound on a pretty large frame, and that this is laid flat on a horizontal table, so that it may be suddenly turned over. By turning it over we cause the direction of the vertical component of the earth's magnetic force in it to be reversed, and thus induce a throw of the ballistic galvanometer due to a known change in the number of lines of induction within the circuit, from which it is easy to interpret the throws that are produced by changes in the magnetism of the specimen.

This "earth coil," as it may for brevity be called, was first used in magnetic researches by Rowland.† Instead of lying horizontally it may stand vertically facing towards the magnetic north and south, so that when turned over it will cut the horizontal component of the terrestrial field, or it may be set at right angles to the dip, so that the whole terrestrial field acts upon it. The horizontal or the vertical position is, however, more convenient. For the former a light wooden frame lying on the table answers well. Fig. 22 is engraved from a photograph of an earth coil, which the writer has found serviceable; the coil is wound on a large brass ring mounted on trunnions and furnished with projecting stops, which strike against the post P and allow the coil to turn just 180 degrees. When the post P is standing up, as in the figure, the coil lies horizontally, and the vertical component of the earth's force is then the active field; but the post can fold down by means of a hinge so

* *Phil. Trans.*, Vol. CLXVI., p. 693.
† *Phil. Mag.*, Vol. XLVI., 1873.

Digitized by Google

that the coil stands vertically, and it may then be set to cut the horizontal component.

Let N_1 be the number of turns in the earth coil, A_1 its area in square centimetres, and F the (known) value of that component of terrestrial magnetic field which acts upon it. A sudden reversal of the coil changes the number of lines within it by the amount $2 A_1 F_1$, and the whole quantity of the transient current is

$$\frac{2 N_1 A_1 F}{R_1},$$

R_1 being the resistance of the secondary circuit at the time when the observation with the earth coil is made. It is convenient and generally quite practicable to keep the earth coil continuously in the secondary circuit, in which case $R_1 = R_2$. Let d_1 be the ballistic throw produced by the earth coil, and let d_2 be the throw produced by the magnetic change ΔQ, which we wish to evaluate:

then,
$$\frac{N_2 \Delta Q}{R_2} : d_2 :: \frac{2 N_1 A_1 F}{R_1} : d_1,$$

from which
$$\Delta Q = \frac{2 N_1 A_1 F R_2 d_2}{N_2 R_1 d_1}.$$

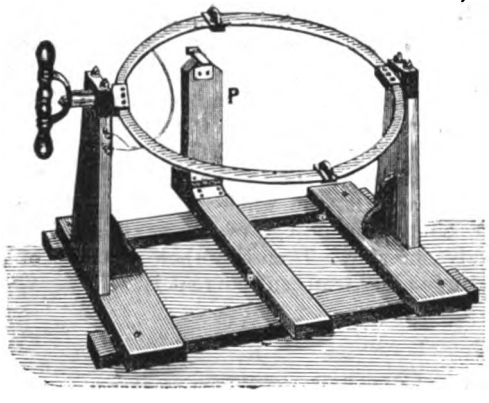


FIG. 22.—Earth Coil for use in the Ballistic Method.

§ 53. **Use of a Solenoid and Current for Standardising the Ballistic Galvanometer.**—To use the earth coil successfully we must know with sufficient accuracy the horizontal or the vertical component of the local magnetic field. These are apt to vary in a rather capricious way within a magnetic laboratory. The following method of standardising a ballistic galvanometer (due, the writer believes, to Sir William Thomson) is a good substitute for the method of the earth coil. The results it gives are independent of variation in the local field, but depend on the absolute measurement of a current. A long magnetising coil is to be uniformly wound on a brass tube or a wooden rod, or some other non-magnetic core, the diameter of which must be accurately known. Over this primary, at the middle of its length, a short secondary coil is to be wound, and put in circuit with the ballistic galvanometer. Let A_3 be the mean area of the primary coil, and n_3 the number of turns in it per centimetre of the length. Then, if a current, C (C.-G.-S. units), is made to pass through it, the magnetic force (or induction) within it (at any place near the middle) is $4 \pi C n_3$ per square centimetre, and the whole number of lines of force (or induction) which the current introduces within the coil is $4 \pi C n_3 A_3$. If N_4 is the whole number of turns in the secondary coil, and R_4 the resistance of its circuit, the quantity of electricity in the transient current that passes when the primary current C is made or broken is

$$\frac{4 \pi C n_3 A_3 N_4}{R_4}.$$

Let d_4 be the throw which this produces, then

$$\Delta Q = \frac{4 \pi C n_3 A_3 N_4 R_2 d_2}{N_2 R_4 d_4}.$$

Still another way of standardising the ballistic galvanometer is to discharge through it a known quantity of electricity, namely from a condenser of known capacity, charged to a known potential. This has no particular advantage over the method already described, and it is less likely to be accurate in practice.

(To be continued.)

ELECTRIC ARC LIGHT CARBONS.

BY O. G. PRITCHARD.

That hitherto we have been unable to cope with France, Austria, Germany, or Bohemia in the production of electric-arc-carbon candles is seen by the fact that our supplies continue to be drawn from Continental manufacturers. Paris claims good makers, such as Carré, Sautter-Lemonnier and Gaudoin, but their prices being high in great measure precludes their adoption on a large scale. Berlin boasts Herr Siemens, Austria Herren Hardtmuth and Schmeltzer, and the Apostle carbon comes to us from Bohemia. These carbons have of late years been much reduced in price, and leave little or nothing to be desired. From America we obtain the Brush carbon, solid and coppered, which eventually we may expect to see superseded by the cored uncoppered carbon. Other large makers also might be mentioned, to whose specialities I need not now refer. Up to the present we stand committed to Siemens, Hardtmuth, and Schmeltzer, who, between them, with the Apostles divide the honours and the profits. Strenuous efforts have been made during the past ten years to introduce a home-made article, efficient and good, but failure alone appears to have waited upon endeavour. This has led to the idea that carbon-candle making can never become an English industry. The writer has, however, produced carbons on a scale of some magnitude which were testified by experts to be quite equal to those of the foreign makers, and he now publishes the whole process employed by him, and the results of eight years' experiments and experience, in the hope that the arc-light carbon industry may eventually become an English one.

The difficulties in the way of producing a perfect carbon, like all other difficulties, vanish with close application to the subject. These various processes, so easily detailed and explained, however, have only been perfected after many years' devotion to the subject and large expenditure of funds. How not to do it is the antecedent to all discoveries, and every inventor, or would-be discoverer of hidden processes, has to learn that only by the continuous registration of negative results can he hope to achieve positive success. I think it will be instructive and also interesting to explain the many faults to which carbons are prone, to diagnose the maladies, and to point out the cause of failure, the necessary preliminary to a cure. The *ultima thule* of carbon perfection, perhaps, has not yet been achieved. Yet I am of opinion that, with the elimination of the faults hereinafter described, a carbon will be produced as near perfection as the severest critic can wish for.

I think we get the carbon and the light in their worst form in the Jablochkoff system. The varying displays of blue, red and yellow, and green lights certainly afford a great choice of colouring, but are undesirable, to say the least. This system, however, being a thing of the past, need not occupy our time. Hissing, also, may now be said to be like the dodo—dead. We come, however, to a serious defect in the little gaseous flame that is sometimes seen to travel round the point of the positive carbon whenever the arc lengthens beyond the normal, and which throws a dark shadow upon the bowl. Also this defect may be enhanced by a faulty lamp not answering quickly to the change in the amount of current, and not allowing the arc to become shortened. This has been attributed to the lamp; but seeing that by removing the carbon, and placing a good carbon in circuit, the effect ceases, the fault must be attributed to the carbon, and upon investigation it will be found to arise from the presence of occluded gases in the body of the carbon. This, again, arises from the improper nature of the material employed, which renders the carbon incapable of receiving or retaining the compression to which it had to be submitted in the press; or it may arise from want of due saturation in an after process, whereby the want of com-

Digitized by Google

pression is got over, and the pores containing these occluded gases are filled with carbonised matter. All or some of these may be assigned as reasons.

But the fault lies in the material employed. I make this statement with boldness, and further assert that the purest carbon is incapable of yielding a good carbon candle, unless it possesses qualities which have to be imparted to it mechanically. The nearest approach which Nature affords for a proper material is gas-retort carbon, inasmuch as the grain is hard, good, and so, well fitted to the purpose. But this material is too impure for use, and is expensive to purify, which prevents its adoption. When the preparation of material is touched upon, this will be more clearly understood. Now, the grain and character of the material, outside and beyond its purity, are matters of moment. By way of more fully illustrating my meaning, let me take the purest lampblack, perfectly suitable *per se* for carbon-making as regards purity, yet, owing to the absence of grain, cannot be made to retain its compression; it occludes gases, and the perfection of the carbon is destroyed, and its life considerably shortened. As far as my experience reaches, I should say that a 10-millimetre carbon (cored positive), 42 volts, 8-ampere current, $\frac{3}{16}$in. arc, gave the highest results. If the arc lengthen to $\frac{1}{4}$in. red flames are produced in the best carbons I have tested.

Conductivity is of the greatest importance, the greater the facility with which the current passes the better the light and the less the E.M.F. required. Thus I think I may state, without experimental data to go upon, but by observation only, that a candle of high conductivity will give as good a light with a 6-ampere current and 38 volts as one of lower conductivity using 42 volts and 8 amperes. Indeed, when the conductivity is very low, the current will not produce the arc, and the carbon becomes intensely heated. This conductivity depends entirely (given pure carbon) on the length of time to which it has been submitted to the firing process. Graphite appears to owe its peculiar condition of high conductivity to its lengthened subjection to Nature's forces, unapproachable by human efforts. Great pressure, continuous and intense heat protracted over long periods, even if possible, would prove commercially impracticable; yet I entertain no doubt that carbon submitted to a white heat, such as would melt wrought iron, for a whole week, would produce a candle more graphitic in character and possessing higher conductivity than one that had been subject to such treatment for a less period. As I deal with the subject of firing, and my special economic arrangements for so doing, this subject will be more fully dealt with.

Again, the duration of the positive carbon is a matter of moment, since it is *de rigueur* that the waste should not exceed 1in. per hour; and as this is now an accomplished fact, it has become a necessity. For some inscrutable reason, foreign makers supply only 10in. positives unless otherwise ordered, so that with 1in. in the holder, and something to spare to save the lamp from heating, little is left besides the 8in. required for eight hours' light. I have met with no material in its native state capable of reducing the consumption to this standard; the prepared material employed by the writer satisfies these conditions.

Another defect, and one which makes the otherwise perfect carbon valueless, is curvature. This takes place in drying and firing. If not properly or sufficiently dried, carbons will not only bend during the firing process, but break into several pieces. The method of avoiding this will find its place further on. With lampblack carbons, fully 50 per cent. will be curved, but with the prepared material described at length, and with proper care taken in the drying, no anxiety need arise. Another matter of grave importance, the consideration of which, if neglected, will lead to most serious results, is the following. A carbon may be selected, placed in the lamp, and found to give perfect results with a normal $\frac{3}{16}$in. arc. Another candle from the same parcel, in the same lamp, gives only a $\frac{2}{16}$in. arc; whilst yet another finds its place of rest at $\frac{1}{4}$in. Now to adjust these varying arcs to produce equal light, the top in one case, and the bottom of the lamp in the other case, will have to be weighted so as to adjust the arcs to a normal length. But when lamps are running in series this constant readjustment becomes impracticable; yet without this readjustment one lamp would be burning properly, another would be burning, but giving a minimum of light, whilst the other would be flaming—each carbon good in itself, but bad when burnt in series. To what, then, is this irregularity to be ascribed, and how is it to be obviated? The answer is simple. The hydraulic press must be fitted with an atmospheric gauge, capable of measuring at every moment the amount of atmospheric pressure to which the carbon matter is being subjected. The best amount of pressure having been discovered, and care being taken that all the carbons shall be made at that pressure, does it not stand to reason that carbons pressed out at 50 atmospheres must give different results to those pressed at 150? And when we hear, as I have heard, that carbons are irregular, and not so good as they used to be, can it not be well understood how a careless workman in charge of the press, receiving a bucket of pugged material, and passing it through the press without taking any heed of the difference in pressure indicated by the gauge, amounting, perhaps, to 20 or 30 atmospheres, vitiates the perfection of the carbon, and does irreparable mischief? The matter lies in the hands of the pressman, who has the gauge for his guide. The man who pugs and prepares the material requires an amount of experience that can only belong to an expert to enable him to grasp a lump of material, and say within 10 atmospheres what the pressure required to pass it through the press would be. Several puggings, and at least three days, are necessary in the preparation of the material. From experience I can say that 120 atmospheres produce good results—nothing under. I have never been able to prepare material requiring a pressure of more than 160; at 120 the carbons leave the press quite warm.

The carbons made by good makers sometimes mushroom. By this is meant the formation of a head resembling a mushroom button upon the extreme point of the negative, which appears to consist of particles of impure matter thrown down from the positive carbon. If this mushroom top increases and does not break off of itself, which it often does, it may touch the centre of the positive cored carbon, in which case the circuit becomes closed and the lamp extinguished. This fault I attribute to impurity of material and the presence of silica, which fastens itself like a glass bead to the point of the negative, and, being a powerful non-conductor, tends to arrest the current. This bead is formed by the electric current searching out the distributed particles of silica in the positive, but without power to vaporise the globule which it deposits on the negative. Pure prepared material is a certain cure.

The lengthening and shortening of the arc, often described as jumping, and which causes the rapid fluctuations in the amount of light, is the characteristic of a bad carbon, badly made with bad material, and owes its existence to a complication of the faults previously mentioned in an exaggerated form.

A word or two upon coppered carbons. Good wine needs no bush, and a good carbon needs no copper. This coating is given to hide a defect; perhaps more than one, since it may be put on to hide a defective surface, whilst a perfect carbon cannot have a bad one. But the chief reason is to get over want of exterior hardness—a very serious fault. Good carbons should be extremely hard on the surface, gradually softening towards the centre, which in the case of cored carbons consists of pure graphite in powder. A carbon insufficiently hardened (hardness being only acquired by repeated saturation and carbonising) burns to a lengthened cone. This is due to the air rushing in to supply the vacuum formed, and which, meeting with little resistance, disintegrates the carbon, and works it to a lengthened cone, presenting only a small point to support the arc, the light in consequence becoming seriously diminished.

Preparation of Material.

Those who desire fuller information upon the nature of graphite, the various parts of the world in which it is discovered, and other details, may peruse "Spon's" with interest. Two kinds are known, the amorphous and the foliated. The amorphous is quite unsuited to our purpose, and contains often only 45 to 50 per cent. carbon, the rest being argilaceous matter. The foliated under careful test has shown as high a percentage of carbon as 99·679. Crucibles and pencils are made of the amorphous. The foliated graphite which comes to us from

Digitized by Google

Ceylon can be readily obtained in any desired quantity from the Mincing-lane brokers, at prices varying from £16 to £22 per ton, and is well adapted to our purpose. It comes to us in the form of nodules, which require careful selection, and breaking under the hammer in small pieces to extract any quartz discoverable. After careful hand-picking, the graphite must be ground to a fine powder in a mortar or pug mill. After this, the powder should be placed in cast-iron mortars or crucibles, and mixed with chlorate of potash in the proportion of 18lb. of graphite to one of the chlorate, and sulphuric acid (sp. gr. 1·8), 2lb. to 1lb. of graphite. This mixture must be moderately heated until the last fumes of the chlorous gas are evolved, and then allowed to cool, when the excess of sulphuric acid should be decanted. Upon this sulphated and oxidised mass pour a small quantity of fluoride of sodium, stir well together, and after the chlorous vapours have passed off, the hydro-fluoric acid set free by the combination of the sodium with the sulphuric acid will convert any silica present into a gaseous fluoride of silica, which passes away in vapour and leaves the mixture pure. This mass should afterwards be thrown into water and well washed, placed again in crucibles, and submitted to a red heat in a furnace. This will cause the whole mass to swell and disintegrate, forming a light flocculent powder floating on the surface, which must be collected and dried. This impalpable powder is yet unsuited for carbon making. A cutting sharp grain must still be imparted to it, and to arrive at this the thin flat plates of gas-retort carbon, taken from the top of the retorts, must be taken and ground fine, in the proportion of one of gas carbon to three of graphite, with which it must be well incorporated in the initial stage, so that its impurities may be equally eliminated. You cannot obtain these thin carbon plates without purchasing the heavier and impurer shoulder-pieces. However, the refuse may be economically employed in furnace heating, as it gives great heat and possesses great durability.

The material so far prepared must be thoroughly dried, and pugged with sufficient caramel or carbonised sugar, mixed with water, to make a moderately stiff paste, placed in ovens or crucibles, and thoroughly carbonised. A material is thus produced possessing all the requisites desirable. It is perfectly pure, and when ground fine possesses a sharp-cutting grain and great hardness, allowing the molecules under pressure to combine to the exclusion of occluded gases, which allows of a perfect homogeneity which could not be otherwise attained. It will be necessary to crush these lumps so prepared in a stone crusher, and after crushing grind them in a mortar mill, passing the powder through a rotary sieve, working from the counter-shaft, having 90 meshes to the lineal inch, or 8,100 to the square superficial inch. In my next article I shall continue with the method of preparing the above for passage through the hydraulic press.

(To be continued.)

THE INSTITUTION OF ELECTRICAL ENGINEERS.

SOME POINTS IN DYNAMO AND MOTOR DESIGN.*

BY W. B. ESSON, MEMBER.

(Continued from page 477.)

12. Load Diagrams.

A dynamo having been completed, its performance should be recorded in such a manner that we shall be able to tell at a glance what a machine of similar carcase dimensions will under any circumstances give. First, the machine is run on open circuit, and the relation between the ampere-turns on the magnets and the E.M.F. established. In Fig. 20, the curve A B shows this, abscissæ giving ampere-turns, and ordinates the E.M.F. While running at the same speed, take the greatest permissible current from the armature, and, keeping this constant, take observations of the magnetising force and E.M.F., the field being weakened down step by step until it is just possible by adjustment of the brushes to run without sparking. For each reading the brushes will have been adjusted to the sparkless position, and the curve expressing the relation between the magnetising force and E.M.F. when the maximum current flows may be plotted as at Q H. The curve stops at H, because with a further weakening of the field a non-sparking position cannot be obtained. Repeat the experiment for a less current in the armature, then for a smaller still, until there is a series of curves—Q H, E F, C D—as shown, representing the relation between the magnetising force and the E.M.F. for several different values of the ampere-turns on the armature. It will be observed that as the ampere-turns on the armature get less the curve can be carried lower, or, in other words, we can weaken the field to a greater extent before arriving at the sparking point.

This load diagram tells us everything we wish to know about the magnetic circuit of a machine having these particular dimensions, and about the interference of the armature on the field circuit. It tells us the ampere-turns required for any induction on open circuit, or, in other words, the magnetising force required for the shunt only if the machine is to be compounded; it tells us how many ampere-turns must be added to raise the E.M.F. by a required amount with any current flowing, or to compensate any armature load; it tells us how we can over-compound the machine; and, lastly, just how far we can weaken the field for any load without producing sparking. That we can by its aid calculate with accuracy the windings of any machine which requires the same carcase, will be sufficiently obvious without farther explanation.

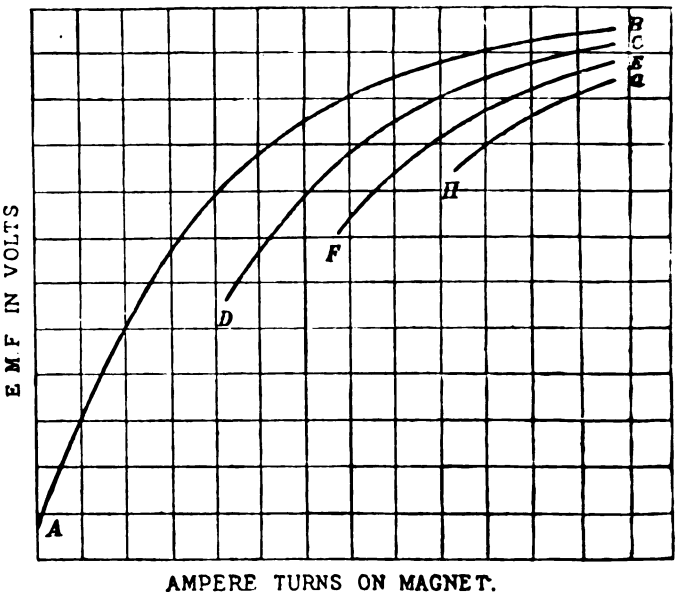


Fig. 20.

13. The Best Relation between the Iron and Copper in the Armature

It is of some importance to know the best relation between the thickness of the iron core and the depth of the winding which will give in armatures the best results for given dimensions. Suppose we have a cylinder armature of certain radial depth over the winding: while keeping this depth the same, we may vary the iron and copper of which it consists within wide limits. The question is, what relation of copper to iron will give the best results, premising that, however the relation is varied, the temperature shall remain the same? The cooling surface we will take to be unaltered, and this means, neglecting hysteresis—for a reason given presently—that the heat generated in the winding shall be constant. Since the waste is constant, the point of maximum efficiency coincides, then, with that of maximum output. If the copper on the outside of the armature is considered as a shell of t thickness, we may, within the limits of our inquiry, take the current that may be carried to generate the same heat $= \sqrt{t}$. The E.M.F. produced will be proportional to the radial depth of the armature core r, and assuming in each case the same degree of saturation, the greatest output for a given radial depth of armature is obtained when $r \sqrt{t}$ is a maximum. This occurs when the exterior layer of copper is about one-fourth the depth of the armature core, the output for different proportions between iron and copper being shown by the curve, Fig. 21. In the diagram the base line A B represents half the radial depth of the armature over the winding, distances measured from left to right giving the thickness of the exterior

* Read before the Institution on February 20, 1890.]

Digitized by Google

shell of copper. The ordinates represent the output. A dotted line, C D, is erected at the point of maximum. It may be assumed, without any great error, that the weight per unit length of circumference is constant, however the proportions vary, so that the curve may be taken to represent maximum output for a given weight as well as for given dimensions. With a square or bar winding this is about correct.

It will be observed that the relation of copper to iron can be varied considerably without making much difference to the output. An armature, for instance, in which the core is six times the thickness of the copper, gives the same efficiency as one in which the relation is 2·75, and the output is in each case only 3 per cent. below the maximum. The relation for greatest efficiency is quite independent of the degree of saturation to which the core is carried, or the temperature at which the machine is worked.

The effect of hysteresis is to reduce the height of the ordinates, and to displace the point of maximum efficiency to the right. The current which can be taken from the armature is a little greater than $\sqrt{t}$, on account of the heat from hysteresis diminishing as the core is reduced in thickness. But, imagining that in all cases the core is saturated to the same degree, the difference in the amount of heat generated from this source is, within the limits of practice, so small a percentage of the whole that its effect on the shape of the curve may be quite neglected.

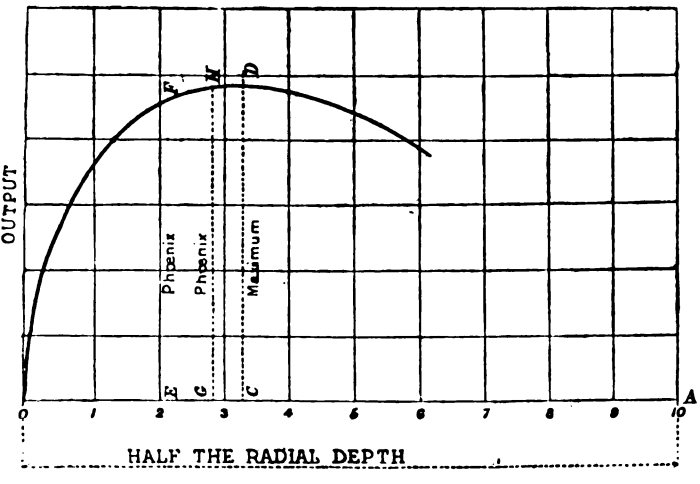


FIG. 21.

Machines are not always designed so that the proportions give maximum output, since other considerations arise besides that of the best result from the armature considered by itself. The question of magnetising the core has to receive attention, and the question is resolved into, What is the best proportion for the machine, considered as a whole? The answer to this depends entirely upon the design. In the Phœnix dynamos we work between the limits given by the two vertical dotted lines E F and G H, in Fig. 21, finding that there we obtain the best results. If we worked to the right we should get a greater output, we should have a greater air-gap, a diminished flux through the armature core, but, on account of the increased stray field, about the same flux in the magnets. The magnetising force and the compensating turns on the magnets would be increased somewhat, while the cross induction would remain about the same. As regards this last point, it is worthy of note that the tendency to sparking, with the usual clearance spaces, remains about the same for considerable variation in the proportion of copper to iron. Increasing the copper does not increase the length of the air-gap in the same ratio, but in a ratio rather greater than $\sqrt{t}$, or than the current which can be taken from the armature. At the same time the radial depth of the core is diminished, the final result being that $\frac{A_2 w}{l r}$ is about constant within the limits of practice.

For drum armatures the relation for maximum output can be similarly determined, and similar conditions fix the limit of departure from the maximum. One point with reference to these considerations should be noticed, and that is, that neither for cylinders nor drums does the point of maximum efficiency or output coincide with the point at which $\frac{\text{watts}}{\text{weight of copper}}$ or $\frac{\text{volts}}{\text{yards of copper}}$ is a maximum, and that these ratios, as applied to compare the performance of dynamos, are accordingly misleading. Given a limiting temperature, the only factors upon which the commercial value of machines should be based are cost and commercial efficiency. Whether the magnets shall be made of wrought or cast iron, whether there shall be a large amount of copper or a small amount, are questions for the manufacturer to decide. In some cases it may pay him to increase the copper and use cast iron, in other cases diminish the copper and use wrought iron. But the finished product is to be judged by its cost to purchase and its cost to run.

14. MOTOR-DESIGNING.

These considerations naturally bring us to the subject of motor-designing, about which there has been expressed from time to time a good deal of difference of opinion. From the preceding section it will be perceived how far we can go in the direction of getting an increased output from a given weight of armature; and it will have been understood from Section 4 that with somewhat lighter field-magnets and a reduced saturation in the armature, a larger yield can be obtained for the total weight, though smaller for the weight of the armature itself. As a general rule, the question of weight does not enter into dynamo-designing, except in so far as cost is affected, and a lighter machine means a somewhat increased cost for the output. But in motors it is sometimes necessary to keep the weight as low as possible; and the point to be emphasised here is that in designing light-weight motors we proceed upon lines precisely similar to those adopted in designing light-weight dynamos.

It has been asserted that in motors the armatures ought to be larger compared with the field-magnets than in dynamos; and by "larger" must be meant either that the armature cross section is greater, or that the ampere-turns on it are more numerous. As regards the former, it has been shown in Section 4 to what extent the relation between the cross sections of the armature and fields influences the dynamo; and the same reasoning applies to motors. As regards the latter, curiously enough, the examples which I have given in Tables II. and III. show no overloading, but about the same number of ampere-turns is carried as by dynamo armatures—a fact which does not favour the "large armature" school. My own experiments with series machines, in which the brushes had equal lead and trail when running as dynamo and motor, seem to show that the difference in the E.M.F. generated under these two circumstances is negligible. In Table IV. are given the results.

TABLE IV.—*Series Machines run as Generator and Motor.*

GRAMME ARMATURE.

Machine.	Revolutions per Minute.	V_1.	V_2.	C.	$V_1 + C R$.	$V_2 - C R$.	Diff.
Phœnix..	820	58	136	12·0	98·00	96·00	- 2·00
	1,700	134	168	5·0	150·60	151·30	0·70
	1,880	136	168	4·5	151·00	153·00	2·00

PACINOTTI ARMATURE.

Phœnix..	820	47	80	4·5	63·00	64·00	1·00
	940	58	96	5·0	75·30	78·70	3·40
	1,295	87	130	6·0	107·70	109·30	1·60
	1,430	104	152	6·75	127·30	128·65	1·25
	1,520	106	158	6·75	131·13	132·87	1·74

BÜRGIN ARMATURE.

Bürgin...	500	16	116	14·0	64·67	67·40	2·73
	640	36	130	12·5	79·46	86·54	7·08
	720	60	98	4·25	74·11	83·89	9·78
	780	59	138	10·0	93·77	103·23	9·46
	830	66	142	9·0	97·30	110·70	13·40
	840	72	118	4·5	87·00	103·00	16·00
	860	70	144	8·75	100·40	113·60	13·20
	1,100	104	152	4·75	119·77	136·23	16·46
	1,180	114	164	5·0	130·60	147·40	17·20

V_1 = Difference of potentials at terminals as generator.
V_2 = Difference of potentials at terminals as motor.
C = Current, in amperes.
R = Resistance of machine in ohms.

The cores of the Gramme and Pacinotti armatures were constructed of iron washers separated from each other by paper; while the Bürgin armature consisted of a series of hexagonal rings made of iron wire, each forced on to a six-armed gun-metal spider. The small differences in the last column may be readily accounted for in the case of the Gramme and Pacinotti armatures by errors of observations, as several things had to be measured simultaneously; but no allowance for errors can account for the difference in the case of the Bürgin machine. I talked over these experiments at

Digitized by Google

the time with Mr. Kapp, who suggested that the difference might be due to parasitic currents arising from imperfect lamination, the forcing of the hexagonal ring on to the spiders bringing the wires of the core into actual contact at the corners. When the currents are flowing in the same direction through the machine, the armature rotates with reference to the field in the opposite direction of course as generator and motor. Now, apart from the question of parasitic currents, with an irregularly formed armature like the Bürgin—and the Brush with its eight or twelve projections would come in the same category—one is not surprised at a difference in the E.M.F. ; the wonder would be if the direction of rotation did not alter the field. But with a Pacinotti ring in which the slots are many and close together, the influence on the field is slight, and with smooth Gramme armatures the field is not affected by the direction of rotation at all, so we get the same E.M.F. produced as generator and motor. It must be remembered that the effect of the armature current on the field in cylinder machines is by no means small, as will have been observed by the number of compensating turns required to neutralise it. A machine having 13,500 ampere-turns on its armature would have about 20,000 on its field-magnets, out of which about 4,500 are compensating turns. I mention this to show that the results in Table IV. were not obtained from machines in which the armature effect was negligible, or anything approaching it. The saturation of the core was about 17,000 C.-G.-S. units.

If a machine is run at the same speed as dynamo and motor, provided the currents in the fields and armature are similar, it will always have a higher efficiency as a motor. If E is the E.M.F. generated by the machine, C the current (imagine it series-wound), and R the resistance, the electrical efficiencies as dynamo and motor are in the ratio of $\frac{CE - C^2R}{CE}$ to $\frac{CE}{CE + C^2R}$, the latter being the greater quantity. If we designate all the other losses save that due to the resistance by p, then for the commercial efficiency we have $\frac{CE - C^2R}{CE + p}$, and $\frac{CE - p}{CE + C^2R}$. If p had the same value as C^2R, the efficiency of dynamo and motor would be similar ; but since p has always a lower value than C^2R, the motor has still the advantage.

15. Constant-Potential Motors.

Now, as regards another thing which we have been told sometimes —that the armature and magnet fields are added in a motor—so far is this from being the case, that, under the usual and proper conditions of a trail on the brushes, the weakening of the field due to the current in the armature may play a most important part in the governing of motors at constant speed. In an article contributed to *The Electrician* in 1886,* I hinted at this, saying, "By reason of the current in the armature reacting to weaken the field, does not a shunt motor contain within itself the germ of self-regulation, which, by suitable proportion, may be made effective without a series coil at all?" Since that date motors have been constructed in which the truth so foreshadowed has been realised.

As already stated, the E.M.F. of a separately excited dynamo is represented by an inclined line, C D, Fig. 15, the inclination showing the weakening of the field produced by the current in the armature. Run as a motor, with a trail equal to its lead as a dynamo, the E.M.F. generated—called in this case the back E.M.F.—will be the same, being greater, therefore, as the current is smaller, and smaller as the current is larger. A shunt motor connected to mains at a constant difference of potentials has its magnets excited by a constant current, and the back E.M.F. varies in this way. Its value, calling E_1, the difference of potentials at the mains, is $E_1 - CR$, and it is, of course, proportional to the induction through the armature and the speed. Generally we require the latter to be constant, so we write,

$$n \propto \frac{E_1 - CR}{N_1},$$

where N_1 is the resultant induction through the armature due to both fields. As we have seen, N_1 is not a constant : there is a weakening of the field proportional to the current ; and for N_1 we can substitute a value, $N - f(C)$, where N is the induction on open circuit, and $f(C)$, that function of the current which represents the weakening effect. Writing

$$n \propto \frac{E_1 - CR}{N - f(C)},$$

it is perfectly obvious that if CR bears the same relation to E_1, as $f(C)$ bears to N, the speed, n, will be constant, and quite independent of the load. Referring to Fig. 15, the height, O C, may be taken as representing the induction when the motor is running with no load ; the sloping line, C D, giving the induction for various currents in the armature. The horizontal line, C E, will represent the induction due to the field-magnets alone, and also the difference of potentials at the mains. If the speed be constant, the length of ordinates between C D and C E represents $f(C)$, and also C R. We see clearly that if the induction is diminished without a proportional reduction of the back E.M.F., the speed will increase ; while, on the other hand, if the back E.M.F. goes down without a corresponding decrease in the induction, the speed will be reduced. If it is found that the speed increases as the motor is loaded—and I have seen this—the field must be strengthened, and the turns on the armature reduced, or the armature resistance increased. If the speed gets less, an opposite course must be taken. A shunt motor, then, will run at a constant speed on a constant-potential circuit without compound winding or any other device, if the armature-field and magnet-field are properly proportioned. A position can generally be found for the brushes where the sparking between the load limits is inappreciable, and the motor may be then trusted with perfect confidence to run at a constant speed.

It must not be thought that because a motor transmits power it is necessary to manipulate electro-mechanical equivalents until we get torque in pound-feet or foot-pounds per revolution, or some other mechanical quantities. This is only a waste of time. In designing a motor, we know the horse-power or watts to be given off on the brake at a certain speed, and if we make the machine run at the proper number of revolutions, and in accordance with the conditions of electrical supply, the torque will come out all right without our troubling about it. Suppose we require W watts to be given out on the brake by a motor working on a constant-potential circuit. The power which must be converted in the armature is greater by a certain amount, p, absorbed in friction of journals and brushes, magnetic friction, and parasitic currents. This amount can be foretold to a certain extent, but may be derived from experiments made with machines of the same kind. The power converted being then $W + p$ watts ; the back E.M.F. being settled as determined by the waste allowable in the armature, the current $= \frac{W + p}{E}$ is obtained ; the procedure in design now being exactly as for a dynamo to give a current of $\frac{W + p}{E}$ amperes by E volts at the same speed. If these conditions are fulfilled the torque may be left to itself.

16. Constant-Current Dynamos.

There seems to be an impression that dynamos for high differences of potentials cannot be worked successfully with Gramme commutators ; the reason for this opinion being, I suppose, the breakdown of some imperfectly-constructed machines. That there is no difficulty with the insulation between the conductors and armature core is obvious from the fact that high-potential alternating-current machines are working successfully with armature sections similarly disposed ; the fault appears, therefore, to have been solely with the commutators. I need only reiterate the remark I made here a short time ago—that there is no difficulty whatever in constructing Gramme machines up to 1,000, 1,500, or even 2,000 volts, provided the designer knows what he is about. Many such machines are to be seen in daily work. Mr. Bogue, of New York, gives me particulars of a Wood dynamo manufactured by his company which gives 9·6 amperes, and a difference of potential of 2,640 volts at its terminals ; Mr. Henrion, of Nancy, constructs Schuckert machines of 1,000 volts ; Messrs. Immisch and Co. have constructed motors as well as dynamos of 1,000 volts ; while Messrs. Paterson and Cooper have a large number of machines running at voltages varying from 800 to 1,500. The latter run without sparking at the brushes, and with perfectly smooth commutators.

Several attempts have been made to compound machines for constant current, all of them uniformly unsuccessful. It is beginning to be realised that—Deprez notwithstanding—it cannot be accomplished, and during the next six years the equations for constant-current compound winding may finally disappear from our text books. But it may take longer.

The method of regulation about which I have to make a few remarks is that of rotating the brushes on the commutator, which has proved very successful in some of the machines to which it has been applied. You need scarcely be reminded that if a series-wound machine is directly belted to a separate engine, the combination is almost self-regulating, such small correction as is required being easily effected by a solenoidal electrical governor. In such cases the speeds of both engine and dynamo vary as the E.M.F., but generally this arrangement is not permissible, in consequence of several machines being driven from the same countershaft ; accordingly, some device for regulating at constant speed has to be adopted.

In machines in which the current is variable we endeavour, as I have said, to make the self-induction as small as possible, and we work with the brushes somewhere between the polar tips where the field is almost neutral, or only of strength sufficient to overcome the slight effect of self-induction, and bring the current up to its

* Review : "Electric Transmission of Energy," by Gisbert Kapp, *The Electrician*, Vol. XVII., p. 131, 1885.

Digitized by Google

normal value before the section leaves the brush. In constant-current machines we work always in the active field under the pole-pieces, and to prevent the flow of an enormous current in the section short-circuited by the brush, considerable self-induction has to be given. Consider an armature in the field (Fig. 16). Opposite the parts marked N and S the induction through a section is *nil*; at A and B it is 16,000, 17,000, or 18,000 C.-G.-S., as the case may be—that is, in the machines we have been speaking of hitherto. If we had here a uniform distribution of field over the poles an attempt at constant current regulation by movement of the brushes would only result in sparking, since in every position the back E.M.F. of self-induction is different. If the induced E.M.F. were in one position balanced by the E.M.F. of self-induction, in other positions it would be over-balanced or under-balanced. Another point is, that if regulation is attempted by working with the brushes partly between the polar tips and partly under the poles, the weakening effect of the armature current on the fields is subject to great variation; accordingly, the poles should be extended until the brushes are under them in every position. The essentials for successful regulation will now be apparent. First, the self-induction should balance the field in every position of the brushes; secondly, the poles should be extended so that the brushes in every position of working are under them. An examination of the curve, Fig. 1, will show that up to an induction of 12,000 or so the co-efficient of self-induction is, roughly, constant; so that an armature core saturated to this degree would have the same E.M.F. of self-induction for a constant current, whatever the position of the brushes. In the Wood dynamo already referred to the induction in the armature is 13,000 per square centimetre, and in the Sperry dynamo, which hails from Chicago, it is about 14,000. Mr. Sperry's remarks I give in full in the Appendix, also those of Mr. Bogue concerning the Wood machine. In both these machines the masses of iron in the magnets and pole-pieces are disposed so that the field is fairly uniform over the poles; but this is by no means necessary, provided the E.M.F. of self-induction balances the field in every position. Making the field distribution uniform, and the self-induction uniform, affords the easiest method, however, of attaining the end in view. It remains only to say that the field of the short-circuited section is greatly reduced in strength by the current in the armature, and that the best number of turns per section must be determined by experiment. It will be evident that the single-magnet type of machine as illustrated in Fig. 7, is the least suitable for constant current; and while in America they choose the best form of magnet for the purpose right away, in this country the attempts at regulation have been made very often by selecting the worst form and chopping away at the poles until it comes about right.

It is unnecessary to describe the various forms of apparatus for shifting the brushes. Briefly, they consist of a mechanical device, electrically controlled, whereby the brushes are moved forwards or backwards on the commutator as the current rises or falls slightly. Upon the rapidity with which this regulator responds to variations in the current depends the successful working of the machine. If the current is allowed to rise or fall outside a small percentage, the adjustment of the fields is thrown out of balance, and sparking results. The importance of having a regulator which is sensitive, and acts with promptitude, will therefore be apparent.

17. Relation of Size to Output.

Great differences of opinion exist about the relation of size to output in dynamos. Prof. Thompson, in his "Dynamo-Electric Machinery," quotes several writers who give the output at figures varying from the square to the fourth power of the linear dimensions; and the subject has been discussed to some extent in this room. Mr. Kapp has worked out the relation; and assuming that in larger machines the space taken up by the insulation is proportionally less, more copper being accordingly got on the armature, he makes the output for a machine whose linear dimensions are increased n times from n^3 to $n^{3\frac{1}{2}}$, the speed being inversely as the linear dimensions. Prof. Ayrton thinks it ought to be higher than $n^{3\frac{1}{2}}$, while Dr. Hopkinson finds that, everything considered, it comes out about n^3. With the single exception of Dr. Hopkinson, I am not aware that anyone has mentioned *the* consideration which, above all, determines this relation—that is, the interference of the magnet and armature fields.

If the armature of a machine is lengthened, the electrical work which can be performed by it is increased in proportion. The magnetising force and the ampere-turns on the armature remain the same, and the forward and cross induction bear to each other the same ratio. Here the electrical work for the same number of revolutions per minute is proportional to the weight of the magnetic system, and rather more than proportional to the total weight. The surface velocity of the armature is of course unchanged. Let all the linear dimensions of the magnetic system be increased n times. The length of each component of the magnetic circuit being n times longer, the magnetising force must be n times greater for the same degree of saturation, the total forward induction having n^2 times its former value. The copper on the armature being n times thicker, the ampere-turns which may be carried to raise it to the same temperature will be $n^{\frac{1}{2}}$, and the output, therefore, at the same number of revolutions per minute, $n^{3\frac{1}{2}}$, the E.M.F. being n^2. If the speed is inversely as the linear dimensions, the output is, obviously, $n^{2\frac{1}{2}}$. Now, in increasing all the linear dimensions—the air gap in proportion—we have increased the tendency to sparking. The lengths of the cross circuits are n times longer; consequently, for n times the ampere-turns on this armature, the ratio of the cross induction to the forward induction would be as formerly. But we have put on it $n^{\frac{1}{2}}$ ampere-turns, and the air gap must be therefore increased in the same proportion, in order that the tendency to sparking may be neutralised. Under these circumstances the magnetising force will be greater than n; but, taking into account the increased air gap, and the increased compensating ampere-turns on the magnets, the weight of copper on these will not be greater than n^3; and this amount we can afford to have on a machine in which the other weights are increased in similar ratio. It appears, then, that, with due regard to the balance of the magnet and armature fields, the output is not quite proportional to the weight, if the surface velocity of the armature remains the same, but that for similar machines it increases as the $2\frac{1}{2}$ power of the linear dimensions. Of course this depends to a great extent upon the original machine. If the armature of this is under-loaded, it may be quite possible in the larger machine to take advantage of the condition that less space is taken by the insulation, and so load it to a greater number of ampere-turns than $n^{\frac{1}{2}}$; but if the balance of fields is to be the same in each, $n^{\frac{1}{2}}$ represents the permissible ratio of ampere-turns. It will be found, I think, that where the output increases directly as the weight, the surface velocity of the armature is in the larger machines greater.

With these remarks I bring this somewhat lengthy contribution to a conclusion.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To night) FRIDAY, March 21st.

PHYSICAL SOCIETY.

5 p.m. Papers to be read: "The Villari Critical Point of Nickel." By HERBERT TOMLINSON, F.R.S. "Bertrand's Idiocyclophanous Prism." By Prof. SILVANUS THOMPSON, D.Sc.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "Electro-magnetic Radiation." By Prof. G. F. FITZGERALD, F.R.S.

SATURDAY, March 22nd.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture: "Electricity and Magnetism." By the Right Hon. Lord RAYLEIGH, F.R.S.

MONDAY, March 24th.

SOCIETY OF ARTS.

8 p.m. CANTOR LECTURE IV. 2: "Some Considerations concerning Colour and Colouring." By Prof. A. H. CHURCH, F.R.S.

TUESDAY, March 25th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Paper to be discussed: "Lough Erne Drainage." By JAMES PRICE, Jun., M. Inst. C.E. Paper to be read, time permitting: "Barry Dock and Railways." By JOHN ROBINSON, M. Inst. C.E.

WEDNESDAY, March 26th.

SOCIETY OF ARTS.

8 p.m. Ordinary meeting. Paper to be read: "Carriage Building and Street Traffic in England and France." By G. N. HOOPER.

THURSDAY, March 27th.

CHEMICAL SOCIETY.

4 p.m. Annual meeting.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. Paper to be read: "Alternate *v.* Continuous Currents in relation to the Human Body." By H. NEWMAN LAWRENCE, Member, and ARTHUR HARRIES, M.D.

FRIDAY, March 28th.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "Foam." By the Right Hon. Lord RAYLEIGH, F.R.S.

SATURDAY, March 29th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture: "Electricity and Magnetism." By the Right Hon. Lord RAYLEIGH, F.R.S.

*** Particulars of meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.

Digitized by Google

The Electrician.

Published every Friday. Price Fourpence; Post Free, Fourpence Halfpenny.
Editorial, Publishing and Printing Offices:

SALISBURY COURT, FLEET ST., LONDON, E.C.

Telephone No. 2714. Telegrams: "ELECTRICIAN NEWSPAPER, LONDON."

All Communications to be addressed to "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN."

All letters intended for insertion in "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. Subscribers should receive their copies by the first post on Friday morning.*

"THE ELECTRICIAN" *is on sale at the railway bookstalls throughout the United Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices as above.*

SPECIAL NOTICE.

Owing to the increase in the number of pages of "THE ELECTRICIAN," in order to partly cover the increased postage, we have been compelled to revise the rates for Foreign Subscriptions, which are now as follows:—

	3 months.	6 months.	12 months
For Foreign Parts and Colonies:—	s. d.	s. d.	s. d.
Within Postal Union	6 6	12 6	24 0
Aden, Borneo, Ceylon, China, India, Japan, Java Labuan Mozambique, New Caledonia, Persia, Philippine Islands, Siam, Transvaal, and Zanzibar	7 6	14 6	28 0
The rates for the United Kingdom remain as follows:—	5 0	10 0	19 6

TO ADVERTISERS.

"THE ELECTRICIAN" *offers exceptional advantages to Advertisers.* **It has the largest circulation of any English Electrical paper, and circulates all over the World.**

Particulars relating to Advertisements will be promptly forwarded on application to the office.

TRADE ADVERTISEMENTS *intended for the current issue must be handed in not later than First Post on Thursday morning.*

SMALL PREPAID ADVERTISEMENTS *(for Rates see page xv.) are accepted up to 4:30 p.m. on Thursday.*

TECHNICAL PRINTING.

"THE ELECTRICIAN" PRINTING AND PUBLISHING COMPANY (LIMITED) *beg to inform Electricians, Electric Light Engineers, &c., that they make a specialty of Technical Printing, and have a Staff thoroughly acquainted with Electro-Technology. They can, therefore, promise Accuracy and Despatch in the Printing of Electrical Catalogues and Electro-Technical Literature generally.*

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.

Royal 8vo, 5s., postage extra.

Early in each year is issued "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK. *The* DIRECTORY *was established in 1883, and the 1889 Edition consisted of more than 600 pages of printed matter. The names and addresses of all persons engaged in the Electrical Industries may be relied upon as accurate. Useful Tables and Electrical Formulæ, and information specially compiled for this work are given, together with popularly-written Biographical Notices of the leading Electricians, Electrical Engineers, &c., accompanied in many cases by Portraits.*

The issue for 1890, which is still further enlarged and improved (making 850 pages), is NOW READY. Orders should be forwarded at once to the Publishing Offices, Salisbury-court, Fleet-street, London, E.C.

CONTENTS OF THE CURRENT NUMBER.

NOTES	487
Magnetism in Iron and other Metals.—X. By Prof. J. A. Ewing, F.R.S. Illustrated. Continued	491
Electric Arc Light Carbons. By O. G. Pritchard	492
The Institution of Electrical Engineers—	
Some Points in Dynamo and Motor Design. By W. B. Esson, Member. Illus. Continued	494
Meetings of Scientific Societies.	497
THE GOVERNMENT AND THE TELEPHONE BUSINESS	498
Reviews	499
Morgan's Automatic System of Electric Signalling	500
The Practical Working of the Electrical Subways of New York City. By William Maver, jun. Concluded	500
Nine Years with the Arc Lamp. By M. D. Law	504
The Heymann Dynamo Regulator. Illustrated	505
The City of London and Southwark Subway Railway	506
Parliamentary Intelligence	506
CORRESPONDENCE—	
Electric Traction.—H. J. S. Heather	507
The "Feeder" Patent. Illustrated. — J. D. F. Andrews	507
Compound Conductors for Dynamo Armatures.—G. B. Luckhoff	507
Subdivided Conductors for Electric Traction.—W. E. Ayrton	508
Testing Galvanometers.—Elliott Brothers	508
The Engineers', Electricians', Builders', and Ironmongers' Exhibition	508
The E. P. Combination Fitting. Illustrated	509
Trade Notes and Notices	509
COMPANIES' MEETINGS, &c.—	
The New Australian Electric Company	510
Newcastle Electric Supply Company (Limited)	511
New Companies Registered	511
City Notes, &c.	511
Companies' Share List	512

"THE ELECTRICAL WORLD" OF NEW YORK.

"THE ELECTRICAL WORLD" OF NEW YORK *can be obtained from* "THE ELECTRICIAN" *Office, Salisbury-court, Fleet-street, London, E.C. The Rate of Subscription (payable in advance), is* **£1 1s.** *per annum. Single Copies* **price 6d. each; post free, 8d.**

"THE ELECTROTECHNISCHE-ZEITSCHRIFT" OF BERLIN.

In future the above Journal (with which has been incorporated "The Centralblatt für Electrotechnik") will be issued weekly instead of fortnightly, the subscription being **£1. 4s. 6d.** *per annum. Single Copies* **6d.; post free, 7½d.**

GOOD FRIDAY.

In Good Friday Week "THE ELECTRICIAN" will be published on Thursday morning (April 3), instead of on Friday (April 4).

Contributors, Correspondents, and Advertisers are requested to take note, and to forward their communications as early as possible, but not later than Tuesday night in Good Friday week.

THE GOVERNMENT AND THE TELEPHONE BUSINESS.

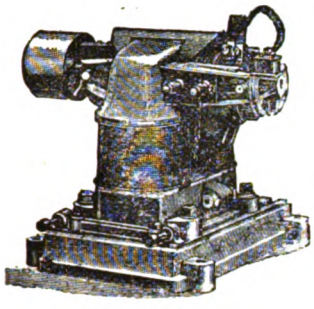
In the House of Lords, on Friday last, the Duke of MARLBOROUGH, who has on former occasions taken the Government to task with regard to overhead telephone and electric lighting wires, preferred a more specific demand for information as to what was intended to be done this year in respect to the owners of the first-named class of wires—that is to say, he wished the Government to make it speedily and publicly known whether they intended to purchase the interests of the Telephone Companies, placing them under the management of the Post Office; or, failing this, whether they would transfer to the companies the unrestricted powers of erecting wires now legally exercised exclusively by the Post Office. Lastly, he wanted to know whether, in the latter contingency the Post Office would confer those powers—or, rather, would refrain from conferring them—on more than, at most, two rival companies. The noble Duke received no definite answer to any of these queries; but it may be safely assumed, without any

Digitized by Google

LAURENCE, PARIS & SCOTT, Ltd.

ELECTRICAL ENGINEERS AND CONTRACTORS,

GOTHIC WORKS, NORWICH.



D-Type Dynamo.

DYNAMOS & MOTORS

NOTED FOR THEIR RELIABILITY, HIGH EFFICIENCY, EXCELLENCE of WORKMANSHIP, & PERFECT MECHANICAL CONSTRUCTION.

PATENT AUTOMATIC SAFETY

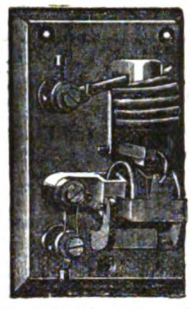
CUT-OUTS,

Are also used as MAIN SWITCHES, and take the place of FUSES.

Have been Thoroughly Tested by over Two Years' Practical Use. Are Perfectly Reliable, and can be Replaced in a Moment.

MULTIPLE SWITCHES, BACK-CURRENT CUT-OUTS, & EXCESS ALARMS, for use with Accumulators.

PRICE LISTS AND ESTIMATES ON APPLICATION.



Automatic Magnetic Cut-Out

THE GENERAL ELECTRIC CO., Ltd. (G. BINSWANGER, Managing Director)

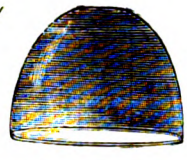
(OF LONDON AND MANCHESTER)

TELEGRAMS "ELECTRICITY."] **71, Queen Victoria Street, LONDON, E.C.** [TELEPHONE No. 1887.

MANUFACTURERS AND SUPPLIERS OF ALL ELECTRIC LIGHT FITTINGS AND MATERIAL.

1,000 FANCY ELECTRIC SHADES.

6d. EACH.



TO CLEAR STOCK ODD PATTERNS.

THE UNITED ASBESTOS CO., LIMITED. DOCK HOUSE, BILLITER ST., LONDON, E.C.

(Late 161, Queen Victoria Street.)

PIONEERS OF THE **ASBESTOS TRADE.**

The **ONLY COMPANY** in the **WORLD** owning & working Asbestos Mines in both **ITALY & CANADA**

FINE ASBESTOS PAPER, for Dynamos, &c.
ASBESTOS TUBES and CEMENT, for Electric Light Leads.
ASBESTOS FIRE-PROOF PAINT, for protecting woodwork, troughs for leads, &c.
ASBESTOS MILLBOARD STRIPS, for ditto.
FINE ASBESTOS THREAD, for covering wires.
ASBESTOS COVERED WIRES.
PATENT SALAMANDER LUBRICANT, for Dynamos, &c.
PACKING, NON-CONDUCTING COVERING for Boilers, &c.

All Goods are made at our Works, near London, and are of the best possible description.

Specify "SALAMANDER" Brand.

Depots: NEWCASTLE-ON-TYNE, Quay Side; MANCHESTER, 34, Deansgate: LIVERPOOL, 47 & 49, South John Street; GLASGOW, 60, West Howard St.; CARDIFF, Mount Stuart Square; ST. PETERSBURG, Gostinoe Dvor.

F. WIGGINS & SONS,

Telephone No. 2248.

10, Tower Hill, E., and 102, Minories, London, E.C.

Manufacturers of MICA GOODS for PHILOSOPHICAL and ALL PURPOSES.

CONTRACTORS TO HER MAJESTY'S GOVERNMENT.

MICA

ELECTRIC TRAM-CARS.

55,000 MILES ALREADY RUN.

Daily Average 300 Miles

(The Greatest Number of Miles ever run in this Country by ACCUMULATOR CARS),

Running on the **BARKING ROAD, E.,**

FOR THE

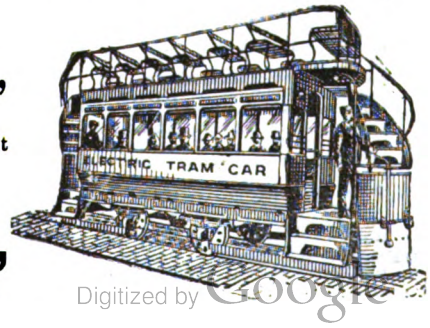
NORTH METROPOLITAN TRAMWAYS CO., LIMITED.

Everyone should see these Cars. Certain to supplant horse and every other form of traction.

Full particulars from the Secretary,

ELECTRIC TRACTION CO., Ltd.,

NEW BROAD STREET HOUSE, LONDON, E.C.



Digitized by Google

"THE ELECTRICIAN" INDEX TO ADVERTISERS.

Advertisers in "The Electrician" have their names inserted under the following headings in this Index FREE OF CHARGE.

ACCUMULATORS. PAGE.
Foreign and Colonial Electrical Power Storage Co., Ltd. 7
ACIDS.—Berk (F. W.) and Co. 20
ALTERNATORS.
Brush Electrical Eng. Co. (Ltd.). 21
Electrical Engineering Corpn... 512
Johnson and Phillips 1
Parsons (C. A.) & Co..... —
AMMETERS.
Acme Electric Works 20
Goolden (W. T.) and Co.....4, 13
Moseley (W.)..... 13
Nalder Bros. and Co. 24
Sharp and Kent..... 14
ANTI-FOULING COMPOSITIONS.—Kirkaldy (J.) and Son. 4
ASBESTOS.
Bell's Asbestos Company.....28, 29
United Asbestos Company (Ltd.) 17
ASBESTOLINE.
Bell's Asbestos Company 28, 29
AUCTIONEERS AND VALUERS (Mechanical).
Wheatley Kirk, Price and Goulty 3
B.A. SCREW THREAD.
Lehmann (Th.) 19
BATTERIES.
Fowler, Lancaster and Co. (Ltd.) 3
India Rubber & Gutta Percha Co. 16, 20
Johnson and Phillips 1
Laing, Wharton and Down 11, 19
Latimer Clark, Muirhead & Co. 1
BATTERY JARS.
Joseph Bourne and Son 19
Cannington, Shaw and Co..... 2
Price, Sons and Co. 25
Stiff (J.) and Sons..... 24
BELTING.
Balderston and Co. ..... —
Moseley (D.) and Sons..... —
Thompson (N. G.)..... —
Willcox (W. H.) and Co..... —
CABLE COMPANIES.
African Direct Telegraph Co. .. 30
Anglo-American Telegraph Co. 33
Brazilian Submarine Tel. Co. .. 31
Direct United States Co..... 33
Eastern Telegraph Co..... 34
Eastern Extension Telegraph Co. 34
Eastern & South African Tel. Co. 30
Indo-European Co. 32
West African Telegraph Co..... 30
Western and Brazilian Tel. Co... 31
CABLE SUPPLIES.
Latimer Clark, Muirhead & Co... 1
Elliott Brothers 21
Felten and Guilleaume 1
Fowler-Waring Cables Co. (Ltd.) 10
W. T. Glover and Co. 19
W. T. Henley's Teleg. Works Co. 1
India Rubber & Gutta Percha Co. 16, 20
Johnson (R.) and Nephew ..... —
Johnson and Phillips 1
Pirelli and Co. 23
Telegraph Manufacturing Co. .. 2
M. Theller and Sons 15
CARBONS.
Brush Electrical Eng. Co. (Ltd.).. 21
Chamberlain (H. and F.) 22
General Electric Co. 17
India Rubber & Gutta Percha Co. 16, 20
Johnson and Phillips 1
Laing, Wharton and Down 11, 19
Thompson (N. G.) (Carré) ..... —
Woodhouse & Rawson United, Ltd. 9
CASINGS.
Acme Electric Works 20
Elliott, Samuel 24
Garrard (Robert) and Co. ..... —
McGaw and Co. 25
CONDUITS.—Johnson & Phillips 1
Fowler Waring Cables Co..... 10
CUT-OUTS.
Acme Electric Works 20
Dorman and Smith 19
General Electric Co. 17
Laurence, Paris and Scott (Ltd).17, 19
Wood (W.) and Co. ..... —
Woodhouse & Rawson United, Ltd. 9
DISINFECTANTS.—Sanitas Co. 20
DYNAMO MANUFACTURERS.
Allen and Co. ..... —
Brush Electrical Eng. Co. (Ltd.).. 21
Latimer Clark, Muirhead & Co.. 1
Crompton and Co. (Limited).... 16
Cuttriss and Co. ..... —
Edison & Swan United Elec. Lt. Co. 5
Electrical Engineering Corpn. .. 512
Goolden (W. T.) and Co.....4, 13
Gülcher Electric Lt. & Power Co. 25
W. T. Henley's Teleg. Works Co. 1
Holmes (J. H.) and Co. 4
M. Immisch..... 13
India Rubber & Gutta Percha Co. 16, 20
Johnson and Phillips 1
Laing, Wharton and Down 11, 19
Laurence, Paris and Scott (Ltd.)17, 19
Oppermann (C.) 22
Parsons (C. A.) & Co..... —
Paterson and Cooper 19
Sharp and Kent..... 14
Telegraph Manufacturing Co. .. 2
Thompson (N. G.)..... —
Western Electric Co..... 23
DYNAMO BRUSHES.
F. H. Royce and Co..... 13
EBONITE & VULCANITE. PAGE.
Harburg India-Rubber Comb Co. —
D. Moseley and Sons ..... —
EDUCATIONAL.
School of Electrical Engineering 6
ELECTRIC BELLS.
Acme Electric Works 20
General Electric Co. 17
India Rubber & Gutta Percha Co. 16, 20
Johnson and Phillips 1
King, Mendham and Co. ..... —
London Electric Wire Co. 19
Julius Sax 19
Telegraph Manufacturing Co. .. 2
Western Electric Co. 23
Woodhouse & Rawson United, Ltd. 9
ELECTRIC CRANES.
Bolton (R.) and Co. 8
ELECTRIC LIGHT CONTRACTORS.
Bernstein Electric Lamp Co..... 2
Brush Electrical Eng. Co. (Ltd.).. 21
Latimer Clark, Muirhead & Co. 1
Crompton and Co. (Limited).... 16
Drake and Gorham..... —
Edison & Swan United Elec. Lt. Co. 5
Electrical Engineering Corpn. .. 512
Foreign and Colonial Electrical Power Storage Co., Ltd. 7
Fowler, Lancaster and Co. (Ltd.) 3
Gülcher Elec. Light & Power Co. 25
W. T. Henley's Teleg. Works Co. 1
India Rubber & Gutta Percha Co. 16, 20
Johnson and Phillips 1
King, Mendham and Co. ..... —
Laing, Wharton and Down (Thomson-Houston) 11, 19
Parsons (C. A.) and Co. ..... —
Paterson and Cooper 19
Shippey Bros. (Limited) 22
Woodhouse & Rawson United, Ltd. 9
ELECTRIC TRAM CARS.
Electric Traction Co., Ltd. 17
Electrical Engineering Corpn. .. 512
ENGINEERS & CONTRACTORS
Acme Electric Works 20
Bernstein Electric Lamp Co..... 2
Blenheim (W.) and Co. ..... —
Booth, Ellson and Co. 15
Brush Electrical Eng. Co. (Ltd.).. 21
Latimer Clark, Muirhead & Co. 1
Chamberlain and Hookham 13
Crompton and Co. (Limited).... 16
Drake and Gorham ..... —
Edison & Swan United Elec. Lt. Co. 5
Electrical Engineering Corpn. .. 512
Fowler, Lancaster and Co. (Ltd.) 3
Foreign and Colonial Electrical Power Storage Co., Ltd. 7
W. T. Henley's Teleg. Works Co. 1
Hulett and Co. (Limited)..... 7
India Rubber & Gutta Percha Co. 16, 20
Johnson and Phillips 1
King, Mendham and Co. ..... —
Laing, Wharton and Down 11, 19
Laurence, Paris and Scott (Ltd.)17, 19
Nalder Bros. and Co. 24
Parsons (C. A.) and Co. ..... —
Paterson and Cooper 19
Julius Sax 19
Sharp and Kent 14
Shippey Bros. (Limited) 22
Starnes (J. S.) and Sons 24
Swinburne and Co. ..... —
M. Theller and Sons 15
Thompson (N. G.) ..... —
Verity (B.) and Sons 25
Westinghouse Electric Company 2
Woodhouse & Rawson United, Ltd. 9
ENGINE PACKING.
Bell's Asbestos Company 28, 29
Starnes (J. S.) and Sons 24
Willcox (W. H.) and Co..... —
United Asbestos Company (Ltd.) 17
ENGINES.
Bailey (W. H.) and Co. (Limited) 14
Brush Electrical Engineering Co. 21
Bumsted, F. D. 24
Crosaley Bros. (Gas) 26
Davey, Paxman and Co. 16
Hindley (E. S.) 17
Marshall, Sons and Co..... 3
Parsons (C. A.) and Co. ..... —
Priestman Bros. (Limited) (Oil).. —
Ransomes, Sims and Jefferies .. —
Richards and Co. 10
Robey and Co. 4
Willans and Robinson..... —
EXPANSION SHEETING AND RINGS.—Bell's Asbestos Co.. 28, 29
United Asbestos Company (Ltd.) 17
FITTINGS for ELECTRIC LIGHT
Crompton and Co. (Limited).... 16
Dorman and Smith 19
Electrical Accessories Company —
Electrical Engineering Corpn. .. 512
Evered and Co. (Limited) ..... —
General Electric Co. 17
Gülcher Elec. Light & Power Co. 25
Hulett and Co. 7
Johnson and Phillips 1
Laing, Wharton and Down 11, 19
Ross, Courtney and Co. 13
Telegraph Manufacturing Co. .. 2
Verity (B.) and Sons 25
Western Electric Co. 23
Wolverhampton Electrical Co... 2
Woodhouse & Rawson United, Ltd. 9
PAGE.
FIBRE.—Moseley (D.) and Sons .. —
FUSES.
Electrical Engineering Corpn... 512
Fowler, Lancaster and Co. (Ltd.) 3
GALVANOMETERS.
Nalder Bros. and Co. 24
GLASSWARE.
Acme Electric Works 20
GAS LIGHTERS (ELECTRIC).
General Electric Co. 17
King, Mendham and Co. ..... —
Woodhouse & Rawson United, Ltd. 9
GLOBES & SHADES.
Dorman and Smith 19
Electrical Accessories Company —
Fowler, Lancaster & Co. (Ltd.) .. 3
General Electric Company..... 17
Hulett and Co. (Limited) 7
INDIA RUBBER.
Moseley (D.) and Sons..... —
Pirelli and Co. 23
INSTRUMENTS.
Acme Electric Works 20
Latimer Clark, Muirhead & Co. 1
Crompton and Co. (Limited).... 16
Elliott Brothers..... 21
General Electric Co. 17
India Rubber & Gutta Percha Co. 16, 20
Johnson and Phillips 1
Moseley (W.)..... 13
Nalder Bros. and Co. 24
Paterson and Cooper..... 19
Sharp and Kent 14
Swinburne and Co. ..... —
Telegraph Manufacturing Co. .. 2
M. Theller and Sons 15
Woodhouse & Rawson United, Ltd. 9
INSULATION.
Aspinall's Enamel ..... —
Johnson and Phillips 1
INSULATORS.
Joseph Bourne and Son 19
Latimer Clark, Muirhead & Co. 1
Gerhardt (C. F.)..... 6
W. T. Henley's Teleg. Works Co. 1
India Rubber & Gutta Percha Co. 16, 20
Johnson and Phillips 1
Price, Sons and Co. 25
Stiff (J.) and Sons 24
Telegraph Manufacturing Co. .. 2
IRON ROOFS & BUILDINGS.
Fredk. Braby and Co. (Ltd.) 27
Francis Morton & Co. ..... —
IVORY LABELS.
Endolithic Ivory Co..... 6
JABLOCHKOFF'S DISTRIBUTION PATENT 512
LAMPS.
Bernstein Elec. Lamp Co. (Inc.).. 2
Brush Electrical Engineering Co. (Ltd.) (Arc and Incandescent). 21
Consolidated Telephone Construction & Maintenance Co, Ltd 12
Crompton and Co. (Limited).... 16
Dorman and Smith 19
Edison & Swan United Electric Light Co. (Incandescent) 5
Electrical Engineering Corpn. .. 512
Fowler, Lancaster and Co. (Ltd.) 3
Gülcher Electric Lt. & Power Co. 25
Holmes (J. H.) and Co..... 4
Johnson and Phillips (Arc) 1
Laing, Wharton & Down (Edison & Swan) 11, 19
Robertson (C. J.) 19
Sunbeam Lamp Co. 12
Western Electric Co. (Arc)..... 23
Woodhouse & Rawson United, Ltd. 9
LIGHTNING CONDUCTORS.
Johnson and Phillips 1
Julius Sax 19
LUBRICANT.
Bell's Asbestos Company 28, 29
Willcox (W. H.) and Co..... —
MANUFACTURING ELECTRICIANS.
Acme Electric Works 20
Latimer Clark, Muirhead & Co.. 1
Dorman and Smith 19
Drake and Gorham ..... —
Electrical Engineering Corpn. .. 512
Elliott Brothers..... 21
General Electric Co. 17
W. T. Henley's Teleg. Works Co. 1
India Rubber & Gutta Percha Co. 16, 20
Johnson and Phillips 1
King, Mendham and Co..... —
Nalder Bros. and Co. 24
Parsons (C. A.) and Co. ..... —
Paterson and Cooper..... 19
Ross, Courtney and Co. 13
Julius Sax 19
Telegraph Manufacturing Co. .. 2
M. Theller and Sons 15
Westinghouse Electric Company 2
Woodhouse & Rawson United, Ltd. 9
MOTORS (ELECTRIC).
Brush Electrical Eng. Co. (Ltd.).. 21
Cuttriss and Co. ..... —
Electrical Engineering Corpn. .. 512
Goolden (W. T.) and Co..... —
Gülcher Electric Lt. & Power Co. 4, 13
Holmes (J. H.) and Co..... 4
M. Immisch..... 13
Laurence, Paris and Scott (Ltd.) 17, 19
Parsons (C. A.) and Co. ..... —
Shippey Brothers (Ltd.) 22
PAGE.
METERS (ELECTRICITY).
Chamberlain and Hookham 13
MICA.—F. Wiggins and Sons 17
NON-CONDUCTING COMPOSITION.
Bell's Asbestos Company 28, 29
United Asbestos Co..... 17
OIL CLEANER.
Woodhouse & Rawson United, Ltd. 9
PAINT, &c.
Indestructible Paint Co..... 32
PATENT AGENTS.—Berg (E.). —
Chapman (J. C.) 13
PIPES (STONEWARE).
Scott and Co 6
PLATINA SCRAPS.
Jamieson (W. & J.) 9
PRINTING AND ENGRAVING.
Waterlow and Sons (Limited) .. 23
POROUS CELLS.
Joseph Bourne and Sons 19
Price, Sons and Co. 25
Stiff and Sons 24
PULLEYS.—Richards and Co. .. 10
RECOHMMETER.
Nalder Bros. and Co. 24
SHEET IRON.
Baldwin (E. P. and W.) 19
SOCKETS.—General Electric Co. . 17
SPEED INDICATORS.
Bailey (W. H.) and Co. (Limited) 14
Blamires (T. and H.)..... 3
SUPPLIES FOR CABLE SHIPS.
Lack (F.) and Sons 24, 32
Starnes (J. S.) and Sons 24
Duncan Wallet and Co. 32
SWITCHES.
Acme Electric Works 20
Crompton and Co. (Limited).... 16
Dorman and Smith 19
Drake and Gorham ..... —
Edison & Swan United Elec. Lt. Co. 5
Fowler, Lancaster and Co. (Ltd.) 3
General Electric Co. 17
Holmes (J. H.) and Co..... 4
Sharp and Kent 14
Thompson (N. G.)..... —
Verity (B.) and Sons..... 25
Wolverhampton Electrical Co... 2
Wood (W.) and Co. ..... —
Woodhouse & Rawson United, Ltd. 9
TELEGRAPH ENGINEERS.
Acme Electric Works 20
Latimer Clark, Muirhead & Co.. 1
Elliott Bros. 21
W. T. Henley's Teleg. Works Co. 1
India Rubber & Gutta Percha Co. 16, 20
Johnson and Phillips 1
Telegraph Manufacturing Co. .. 2
Theller (M.) and Sons 15
TELEGRAPH PAPERS.
Waterlow and Sons (Limited) .. 23
TELEPHONES.
Blenheim (W.) and Co ..... —
Consolidated Telephone Construction & Maintenance Co, Ltd. 12
Stanhope Company 25
Theller (M.) and Sons 15
TOOLS.—Fenn and Co. ..... —
TRANSFORMERS.
Brush Electrical Engineering Co 21
Electrical Engineering Corpn. .. 512
Gülcher Elec. Light & Power Co. 25
Johnson and Phillips 1
Sharp and Kent 14
Swinburne and Co. ..... —
TUBES, &c.—Spencer (John) 7
TYPE-WRITING.
Richardson (W. J.) and Co..... 26
VALVES.—Mosses and Mitchell .. 511
VENTILATING ENGINEERS.
Blackman Ventilating Company. 3
VOLTMETERS.
Acme Electric Works 20
Drake and Gorham ..... —
Edison & Swan United Electric Light Co. 5
Goolden (W. T.) and Co.....4, 13
Moseley (W.) 13
Nalder Bros. and Co. 24
Sharp and Kent..... 14
VULCANISED FIBRE.
Mosses and Mitchell..... 511
VULCANITE.
Harburg India-Rubber Comb Co. —
Moseley (D.) and Sons ..... —
WATCHES (NON-MAGNETIC).
Bedford (H. W.)..... —
WIRE (Covered or Uncovered).
Latimer Clark, Muirhead & Co.. 1
Felten and Guilleaume 1
Fowler-Waring Cables Co., Ltd. 10
W. T. Glover and Co. 19
W. T. Henley's Teleg. Works Co. 1
Johnson (R.) and Nephew ..... —
Johnson and Phillips 1
Laing, Wharton and Down 11, 19
London Electric Wire Co..... 19
Phillips Bros. 13
Phosphor Bronze Company 5, 13
Telegraph Manufacturing Co. .. 2
Western Electric Co. 23
WIRE-COVERING MACHINES.
Barraclough and Co. 3
Johnson and Phillips 1
WOOD (*see* CASINGS).

Digitized by Google

DORMAN AND SMITH,

Electric Light

ENGINEERS; MANUFACTURERS

To all the Principal Contractors.

BRAZENOSE STREET, MANCHESTER, ENGLAND

E. P. & W. BALDWIN,

Works:—WILDEN, near STOURPORT.

MANUFACTURERS OF

PURE CHARCOAL SHEET IRON, SUITABLE FOR ELECTRICAL PURPOSES.

London Agents: BROOKER, DORE & CO., Corbet Court, LONDON, E.C.

INCANDESCENT LAMPS

FOR SHIPPING AND EXPORT.

LAMPS OF ALL VOLTAGES & CANDLE-POWERS

FITTED WITH ANY FITTINGS.

The Quality and Durability of these Lamps can be attested by Users and Customers during the past Three Years.

Prices.—For Lamps of between 5 and 25 c.-p., any Volts or Efficiency, including Fittings of any of the usual makes, Cases, Packing and **Free Delivery** in the United Kingdom and many other countries, from **1s. 11d.** to **2s. 6d.** each, according to quantity.

For further particulars and Samples address—

C. J. ROBERTSON,

100, ALDERSGATE STREET, LONDON, E.C.

BRITISH ASSOCIATION STANDARD SCREW THREAD

TAPS, SCREW PLATES, DIES, GAUGES, &c. ($\frac{1}{4}$ to $\frac{1}{32}$ in.),

SUPPLIED BY **TH. LEHMANN,** Original Maker to G.P.O.

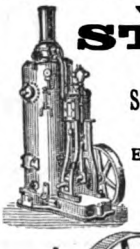
38, HAMPSHIRE STREET, TORRIANO AVENUE, LONDON, N.W.

E. S. HINDLEY,

ENGINEER.

London Show Rooms and Stores— 11, QUEEN VICTORIA ST., E.C.

Works— BOURTON, DORSET.



STEAM ENGINES

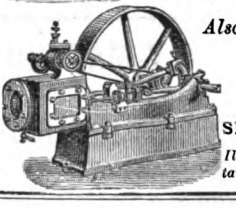
HORIZONTAL, VERTICAL, PORTABLE AND FIXED.

SPECIALLY SUITABLE FOR ELECTRIC LIGHTING PURPOSES.

Small Engines for Installations of 6 20 c p. and upwards.

ECONOMICAL TO USE. MODERATE IN PRICE.

These Engines are controlled by E. S. HINDLEY'S new Governor, which maintains a perfectly uniform speed under sudden variations of work, and is adjustable when working.



Also **STEAM ENGINES**

FOR ALL PURPOSES.

SAW BENCHES,

PUMPS.

SHAFTING, PULLEYS, &c.

Illustrated Catalogues, Photos, and detailed Information free on application.

ADDRESSES.

LAING, WHARTON, & DOWN, 82a, NEW BOND- STREET, LONDON, W., Electric Light Engineers & Contractors. Sole Operators for England of the Thomson-Houston system of Arc Lighting. Special Agents for the Edison-Swan Co.'s Incandescent Lamps and Apparatus. Manufacturers and Suppliers of every requisite for Arc or Incandescent Lighting, Dynamos, Lamps, Switches, Electroliers, Brackets, &c. Specialities in Primary Batteries for Electric Lighting, Venetian Shades and Glass, Carbons, &c. Temporary lighting on any scale at short notice. Estimates free. Telephone No. 3602.

JULIUS SAX, Electrical Engineer and Electric Light CONTRACTOR, RIDGMOUNT STREET, STORE STREET, LONDON, W.C.

Established 1855.

Specialities—Electric Bells, Burglar Alarms, Fire Alarms, Watchmen's Clocks and Fire Indicators combined, Water Gauges, Billiard Markers, Electric Vanes, Lightning Conductors, Speaking Tubes, Gas Lighters, Electrical Testing and Telegraph Instruments, Electrical Torpedo Apparatus.

Automatic Call Bells for Fire Stations, &c., fixed at all Stations under the control of the Metropolitan Board of Works.

Cell Calls for Police Stations, Prisons, &c., as devised for and adopted by H.M. Home Office. Contractor to H.M. Post Office and War Office.

Electric Lighting—Domestic and Public. Estimates Free on Application. Eight Prize Medals awarded.

Telephone No. 3848. Telegraphic Address: "*Sax—London.*"

WALTER T. GLOVER & CO., Electric Wire and Cable Makers, SALFORD, MANCHESTER. Works: Bridgewater-street, Broughton-road, Salford; Salford Electric Wire Works, Salford; Springfield-lane Cable Works, Salford. Established 1868. London Address, 10, Hatton-garden, E.C.; Telegram, "Phonoscope," London; Telephone No. 6691. Manchester—Telegram, "Walter Glover," Salford; Telephone No. 1187.

Specialities—Glover's patent covered Gutta Percha Wire for Leading-in, Tunnel, and Underground Work. Specially covered Iron and Copper Wire for Aerial Lines. Fancy covered single and Double Copper Wire (Paraffined) for Telephonic and Bell purposes. All classes of Silk and Cotton covered Wires for Instruments and Dynamo Machines, Glover's Patent Electric Light Leads and Cables for the various systems.

All descriptions of Covered Wire and Cables for Telegraphic, Telephonic, and Electrical Work, as supplied to the Post Office and the principal Railways, Electric Light, and Telephone Companies.

ADDRESSES.

LAURENCE, PARIS and SCOTT, Limited, Electrical ENGINEERS and CONTRACTORS, GOTHIC WORKS, KING-STREET, NORWICH. Dynamos, Motors, Automatic Cut-Outs, Back Current Cut-Outs, Excess Alarms, Multiple Switches, and Switch Boards. Complete Electric Lighting Plants. Central Station Plants. Estimates on Application.

PHILLIPS BROS., Electrical Wire Manufacturers, The Lea Telegraph Works, HACKNEY WICK, LONDON, E., late of Macintosh-lane, Homerton. Established 1870. Telephone No. 5422.

Specialities—Gutta Percha, India Rubber, Compound, Cotton, Silk, Flexible Cords, Telephone Wire, &c., &c. Multiple and other Wires. Special Wires for Dynamo Machines. Electric Light Leads, &c. Patent Non-Inflammable Insulation for Incandescent and Arc Lighting and Dynamo Machines.

THE LONDON ELECTRIC WIRE COMPANY, ANCHOR WORKS, PLAYHOUSE-YARD, GOLDEN-LANE, LONDON, E.C. (Late of Wenlock-buildings, Ironmonger-row, E.C.)

Specialities—Covered Wires of all descriptions for Electrical Instruments, Dynamo Machines, Bell and House Work, &c. Fancy Paraffined Wires specially prepared for Telephone and other indoor connections.

JOSEPH BOURNE and SON. Works: DENBY POTTERY, near DERBY. London: 6, ST. PANCRAS STATION. Manufacturers of the well-known Stoneware Telegraphic Insulators and Battery Jars. Brown Stoneware. White Stoneware. Brown Porcelain. Porous Cells. Economy, strength, durability, and perfect insulation combined. Prize Medal, Paris Electrical Exhibition.

Makers of Mr. Slater Lewis's Patent Self-Binding Insulator.

J. G. STATTER and CO., Limited, Engineers, ALLIANCE ENGINEERING WORKS, WEST DRAYTON. London Offices, Prince's Mansion, 68, Victoria-street, Westminster, S.W. Dynamos and Motors for all Purposes. Perfect Constant-Current System of Arc Lighting. Estimates free. Write for Lists.

PATERSON and COOPER, Electric Light and Power and Telephone Engineers. EUROPEAN WORKS, POWNALL ROAD, DALSTON (Near Haggerston Station). Contractors to H.M. Government, Leeds Corporation, &c.

Specialities—Phœnix Dynamos, Pilsen, Phœnix, and Clark-Bowman and J. F. Arc Lamps, Cardew's Voltmeter, Paterson's Electromagnet Am- and Voltmeter, Ayrton-Perry Am- and Voltmeters, Wallace Diamond Carbons, Switches, Safety Junctions, and Fittings for Arc and Incandescent Lighting. (Removed from 76, Little Britain, since Nov. 16, 1885)

Digitized by Google

THE
INDIA RUBBER, GUTTA PERCHA, & TELEGRAPH WORKS
COMPANY, LIMITED.

Offices: 106, CANNON STREET, LONDON, E.C.

MANUFACTURERS OF
DYNAMO MACHINES,
INSULATED ELECTRIC LIGHT WIRES AND CABLES,
Lamp Fittings, Switches and Testing Apparatus, Volt and Ampere Meters.
CONTRACTORS FOR THE SUPPLY AND FITTING UP OF
ELECTRIC LIGHT APPARATUS
OF EVERY DESCRIPTION.
INSTALLATIONS FOR CENTRAL STATIONS, SHIPS, HOUSES, OR FACTORIES.
ESTIMATES ON APPLICATION.
Works: SILVERTOWN, LONDON, E.
[See detailed advertisement facing "Notes."

BAR-LOCK TYPEWRITER
W. J. RICHARDSON & Co. 12 & 14, QUEEN VICTORIA St. LONDON, E.C.

THE ONLY MACHINE
ON WHICH
THE WRITING IS VISIBLE,
AND EVERY LETTER
Printed on a Straight Line.
Will Manifold SIX Good Copies of a Specification at One Time.

SPECIMENS OF WRITING AND FULL PARTICULARS POST FREE.
TYPEWRITER COPYING DEPARTMENT. — ENGINEERING SPECIFICATIONS correctly COPIED with Despatch; One to Six Copies written Simultaneously; every Letter and Figure Printed on a Straight Line and Correctly Spaced. Price per Folio, 1½d. to 2d. Send a Trial Order to Test the LEGIBILITY and NEATNESS of the Writing.
W. J. RICHARDSON & CO.
12 & 14, QUEEN VICTORIA STREET, LONDON, E.C.

F. W. BERK & Co.
MANUFACTURERS OF
SULPHURIC ACID. NITRIC ACID. MURIATIC ACID.
ALL STRENGTHS PREPARED ACCORDING TO REQUIREMENTS.
WORKS: ABBEY MILLS CHEMICAL WORKS, STRATFORD, E.
PENTREPOTH CHEMICAL WORKS, MORRISTON, NEAR SWANSEA.
OFFICES: 1, FENCHURCH AVENUE, LONDON, E.C.

THE
ACME ELECTRIC WORKS
(ARTHUR C. COCKBURN, M.I.E.E., Manager),
FERDINAND STREET, CHALK FARM ROAD, N.W.
Offices and Showrooms: 17, Prince's Street, Hanover Square, W.
MAKERS OF
AYRTON and PERRY'S
PATENT MAGNIFYING SPRING
LONG-RANGE AMMETERS & VOLTMETERS
No Permanent Magnet Used. No Table of Values nor Multiplier Required, but each Instrument is Direct Reading throughout the Entire Range of the Scale.
The Divisions are Practically Equidistant all round the Scale; but, by employing a New Method of Constructing these Instruments, the Scale is now Graduated Correctly at ALL PARTS, and not merely at three points, as in the Older Type of these Magnifying Spring Instruments.
Every Instrument is tested by the Inventors, & bears their Certificate of Accuracy.
SOLE MAKERS OF
COCKBURN'S PATENT SWITCHES & CUT-OUTS.
Prices on Application for Above and Every Other Requisite for Electric Light Work.

TRADE "SANITAS" MARK.
DISINFECTANTS
(FLUIDS, POWDER, SOAPS),
NON-POISONOUS, PLEASANT AND BEST.
Used by more than 1,000 Boards of Health and Hospitals.
Gold Medals, Calcutta 1883-4, Paris 1885, Antwerp 1886.
For use at the Home and Foreign Stations of Telegraph Companies and on Board Ship.
"Valuable Antiseptic and Disinfectant.—*Times.*"
"Safe, pleasant, and useful."—*Lancet.*
The "Sanitas" Company, Limited,
LETCHFORD'S BUILDINGS, BETHNAL GREEN, LONDON.

Digitized by Google

question at all, that the indiscriminate competitions which he seems to apprehend will never be permitted by the present or any other Government of this country. Nay, further, it would be contrary to the policy hitherto pursued, and manifestly contrary to public convenience, to permit the competition of even two companies over the same area; for although this is a power held in reserve for the protection of the public against the arbitrary action of any one company, its application would be attended with very great evils, foremost among which would be the destruction of that unity of system upon which so much of the convenience of telephony depends. So great, indeed, is this advantage that probably the Post Office has long ago discovered that its nominal right to start competition itself, or to depute it to other hands, is practically inoperative.

As regards competition on the part of the Post Office, it has never taken the business in hand to any considerable extent; and the faint show of rivalry which was exhibited in the west and north of England last year, and which excited much trepidation among the companies at the time, does not appear to have been persevered with. And what it will not do on its own account we may be sure it will not offer to anybody else, and would probably not be accepted if offered, for the reason that competition would be a very hazardous experiment on the part of any new comer. The Duke of MARLBOROUGH and his clients may, therefore, make themselves easy on these points, though we doubt if there is much comfort to be derived from the assurance. It only narrows the issue to a rather painful alternative, that of letting the companies entirely alone, granting them no more powers than they possess at present, and demanding the same, or even heavier royalties; or, of taking advantage of the expiring patents to drive a hard bargain, and get the whole business into Government hands. Almost certainly the expressed intention of the Postmaster-General to review the terms of the agreement between him and the companies at the first opportunity will be acted upon; and the answer of Lord BALFOUR on the part of the Government last Friday plainly indicated that the relations between the two parties were even now under serious consideration. He went on to say, further, that large questions of private right were involved, urging this as a reason for not making them a subject of Parliamentary inquiry at the present stage. This language about private right may or may not be significant of what is taking shape; but, on the other hand, the statement that the more proper course to pursue was to wait till the Government made up their minds and placed their proposal before Parliament in due form, may be taken as evidence that nothing yet has been decided.

This being the position of affairs, it behoves the companies to bestir themselves to meet a crisis in their career which, for good or evil, will speedily overtake them. They must make up their minds, on their part, as to what they really want, and endeavour to enlist sympathy on their behalf by taking the public into their confidence. At the present moment there is as much uncertainty as to what the Telephone Companies really desire, as to what the Postmaster-General really intends. We only repeat what is notorious when we say that a good many people suspect that the companies wish above all things to be bought up by the Government. For our own part we have no opinion on the subject one way or the other; but we do think that if the companies desire to continue their existence it is about time they made the fact generally known. They have an excellent case if they care to present it in a genuinely argumentative form; but, as we have never yet seen anything like a good case set forth on their behalf, it seems no part of our duty to frame one for them. Either they have done their best for the public with the means at their disposal, or they have not; either they have earned their title to a further lease of life, or they have not. Of course, the public are not satisfied on these points; the public never are; but, failing any appeal to them for a more favourable view of their obligations, the companies cannot be surprised if a verdict adverse to their pretensions is given by default.

There remains only one other matter to comment upon in the short discussion which took place in the House of Lords on the occasion here referred to. It seemed to be taken for granted by the Duke of MARLBOROUGH that the telephone, if utilised to its utmost extent, would seriously impair the receipts of the telegraph service. The companies, who rather pride themselves upon it, are mainly responsible for the prevalence of this impression. All the same, we believe it to be a complete mistake. Mr. SCUDAMORE, when asked if he had taken into account the probable loss of postal revenue consequent upon the cheapening of telegraphic communication, replied that he had only thought it worth while to reckon on the probable gain. Similarly it may be said of the telephone, that the increase of facilities in one direction will multiply the employment of them in the other. No diminution of telegraphic receipts is perceptible due to competition of the telephone or any other cause. The receipts from the telegraph are steadily increasing; and if telephonic business increase, so to a like extent, and for similar reasons, will telegraph business. On the Continent this fact seems to have been taken into account by the several Continental Governments—notably in Austro-Hungary and Scandinavia, where the trunk lines are worked by the State, the local exchanges remaining in private hands. Possibly some such compromise may be brought about in this country; but the subject is highly conjectural, seeing that the trunk lines are the least certain of being profitable to anybody that takes them in hand; and for the present, therefore, nothing remains but to imitate the Duke of MARLBOROUGH, who, failing to extract any useful information, good-humouredly consented to wait until the Government made up their minds.

REVIEWS.

Electric Light: its Production and Use, Embodying Plain Directions for the Treatment of Dynamo-Electric Machines, Batteries, Accumulators, and Electric Lamps. By JOHN W URQUHART. (London: Crosby, Lockwood, and Son.)

This is the third and enlarged edition of a work concerning which there can be but one opinion. Since its first issue in 1880 it has been revised, partly re-written, and brought well up to date. The writer is clear in his arrangement, his description possesses a lucidity in keeping with the title of the book, and the illustrations, which are freely scattered throughout, are both accurate and intelligible. Batteries, dynamos, lamps, carrying-systems, appliances, fittings, details of cost and measurement, are all faithfully dealt with, and the text is interspersed with practical directions, hints as to construction, &c. The author states the efficiency of the chief systems, and informs the reader where typical instalments of these may be inspected in actual use; at the same time their respective merits are calmly discussed without prepossession or prejudice. The book may be further described as a complete directory of the more important patents, and as a miniature *vade-mecum* of the salient facts connected with the science of electric lighting. It is essentially of an elementary character, and may be commended to the young electrical engineer, who will find it a convenient hand-book. By the ordinary lay-student of electric lighting Mr. Urquhart's guidance may also be accepted with confidence. The subject has been dealt with historically, and the reader will find the complete evolution of modern electric lighting carefully traced out.

Digitized by Google

MORGAN'S AUTOMATIC SYSTEM OF ELECTRIC SIGNALLING.

A public demonstration of the system of automatic electric signalling, due to Mr. Frank E. Morgan, of New Haven, Connecticut, was given on Tuesday afternoon, at the Westminster Palace Hotel. The system devised by Mr. Morgan for police signalling resembles in some respects the one which was recently tried by the metropolitan police at Islington, and which was introduced into this country by the Public Safety Signalling Association.

The apparatus at the police-station comprises a receiver, a transmitter, a telephone, and a switchboard. The receiver is arranged so as to be started from any spot where a local substation is provided, and to automatically indicate both the point of origin of the message and its nature. In connection with every police-station it is proposed to erect similarly equipped sub-stations; and at the demonstration on Tuesday these substations were located in a special form of street lamp-post; each of these lamp-posts being provided with a visual alarm-signal, actuated from the central office. It is also proposed to provide special keys to responsible citizens, by means of which they can raise an alarm when necessary; practical joking being in some measure guarded against by the fact that these keys are marked and cannot be withdrawn from the keyhole in which they have to be inserted until the door of the lamp-post is opened by a policeman. A further development of the idea is, for a small annual sum, to provide householders with a transmitting apparatus connected direct to the central office in the same manner as the street posts.

The receiver has a dial face, on the outer edge of which are arranged numbers corresponding to the numbers of the street posts, while on the inner edge there are various printed messages. The current from a street post releases a catch, sets the apparatus in motion, and in the space of a few seconds the two pointers on the face of the receiver point respectively to the post from which the current was sent, and the nature of the message transmitted. The transmitting apparatus is also of the dial pattern, but is only provided with messages. When it is desired to speak to a street post it is necessary first of all to cause a policeman to come to the spot. To effect this a plug is inserted into the numbered hole on the central office switchboard corresponding to the post it is proposed to communicate with. This brings a powerful current into play, which actuates an electro-magnet at the substation, lighting the gas and raising a red cover. The pointer on the transmitter dial is now set at whatever message it is desired to send, and a crank is moved forward to close the circuit, and the message is transmitted. Means are also provided for leaving a permanent record at the central office of the visits of an officer to his post.

Mr. Morgan's apparatus, it will thus be seen, provides for every likely requirement of the police. That some such system of automatic signalling would be a valuable aid to the police authorities goes without saying; and the question of its adoption depends entirely on its ability to stand the rough test of everyday work, and on its cost.

This system, which has been introduced into this country by the Morgan Automatic Electric Signal System Syndicate, would obviously, with a modification of the messages on the transmitters and receivers, be of service in large hotels, &c.

THE PRACTICAL WORKING OF THE ELECTRICAL SUBWAYS OF NEW YORK CITY.*

BY WILLIAM MAVER, JUN.

(Concluded from page 478.)

Electric-Light Cables in Subways.

In the electric-light service in the subways, and I am aware that it is around this that the greatest interest centres, there are, exclusive of the Edison system, four different types of insulation used—namely, the Bishop Rubber Compound, the Standard Underground, the Safety Insulated, and the Cobb Vulcanite Paraffin cables. All these cables are lead-covered.

The Standard Underground Cable.—The insulation of the Standard Underground Cable is obtained by first wrapping thick cotton thread or cord around the wire to any desired thickness. The wire thus covered is then placed in a cauldron of boiling insulating compound—a product of petroleum. This treatment displaces any moisture that may be in the cotton thread. After the cotton has been thoroughly saturated with the compound the whole is then lead-covered. Care is of course taken by soldering up the ends of the cable to prevent absorption of moisture in shipment and in drawing into the ducts. There are now in actual service for electric-lighting purposes in the New York subways over 95 miles of this cable, carrying currents of an E.M.F. of from 300 to 3,000 volts, including many 1,000-volt alternating circuits, and an additional 50 miles of the same cable will shortly be in operation.

The "Safety" Cable.—The insulating material of the "Safety" cable is an india-rubber compound. It differs somewhat, I believe, from the ordinary run of india-rubber compound cables in that the compound is placed over the wire, without seams or laps of any kind. This compound is vulcanised to a moderate degree of hardness sufficient to prevent decentring of the heavy conductors which it insulates, but yet it retains a high degree of flexibility. The thickness of insulation used in No. 4 Brown and Sharpe wire —·204in. diameter—is ·108in. The weight of this conductor, lead-covered, is 4,861lb. per mile. A special thickness of this insulation was made in one instance in response to a call for cable to withstand a strain of 7,000 volts for arc lighting. The thickness of the insulation was ·238in. The conductor is No. 4 B. and S. gauge. This cable is now in the subways. Its length is about three miles. I am not aware that it has yet been called upon to withstand the prescribed 7,000 volts. There are now over 65 miles of the "Safety" cable in actual use in the subways assigned to electric-light circuits carrying continuous and alternating currents of from 1,000 to 2,500 volts E.M.F., and about 15 miles additional are now being placed in subways.

The Bishop Rubber Compound Cable.—The Bishop Rubber Compound Cable is of the well-known Silvertown type. There are two sizes of this cable in the subways—namely, No. 4 B. and S., and No. 6, B. and S. The thickness of the insulation is $\frac{4}{32}$in.; the thickness of the lead covering is $\frac{5}{64}$ of an inch; the outside diameter of the cable is ·65 of an inch, and the weight of the cable is about 3,432lb. per mile. There are of this cable, in successful operation, about 10 miles assigned to alternating currents of 1,000 volts, and five miles to arc circuits of 2,500 to 3,000 volts E.M.F. Double this amount of this cable will soon be laid for similar purposes.

The Cobb Vulcanite Paraffin Cable is of a somewhat unique design. It differs materially in one respect from the other cables described, in that the conductor is freely movable within its insulating medium. The cable is made in practically the following manner:—A vulcanite tube is first made in lengths of about 300ft. This tube is moderately flexible. The tubing is vulcanised in boiling paraffin. The wire is then threaded through the tube, after which the sections of tubing are jointed together. A thick cord is then wound spirally around the vulcanite tube. The whole is then lead-covered, and the space between the vulcanite and lead formed by the spirally wound cord is filled with paraffin. There are about 25 miles of this cable in the subways.

In the case of the Bishop, Safety, Cobb, and Patterson cables, the lead is alloyed with about 3 per cent. of tin. The lead covering of the Standard Underground cable is unalloyed, but it is covered with a thick cotton braiding soaked in "P and B" paint (the latter a product of petroleum), which, it is claimed, will protect the lead from acid gases, &c., and the braid also acts to protect the lead from mechanical injury. All of these cables are guaranteed by the manufacturers for three years.

Condition of the Cables.

It is over a year since current was turned on the first high-tension electric-light circuit in the New York subways. This was a circuit in 125th-street, belonging to the Harlem Electric Light Company. The insulation resistance of the cable, as measured just before the turning on of the current, showed it to be 1,750 megohms per mile. A test made of the same circuit last week, after one year's continuous service, showed it to have an insulation resistance of 1,516 megohms per mile. Since the installation of the circuit just referred to, electric-light cables of the various types described have been drawn into the subways almost as rapidly as they could be manufactured, and test made of the conductors months after the initial test has shown them to be in the same electrical condition as when first laid. There have been several burn-outs in cables in the subways within the year, but with the exception of an abandoned type of cable, to which I shall refer later, these burn-outs have been traceable in every case to de-

* Abstract of a Paper read before the American Institute of Electrical Engineers, New York, February 18, 1890.

Digitized by Google

fective joints or to mechanical injury. In all, according to the best obtainable information, there have been, exclusive of those in the abandoned cable, but five burn-outs in over 185 miles of electric-light wire during a period ranging from one month to thirteen months. In the case of 27 out of 34 of the electric-light circuits in the subways, not a single defect of any kind has occurred since they were placed in the ducts.

Defective Cables.

In the case of the cable previously referred to as having been abandoned, the burn-outs were of almost nightly occurrence. This was a lead-covered cable with a vulcanite tube as an insulating medium. This special cable has, I believe, been abandoned, and is no longer in service in the New York subways. What may appear a singular feature in connection with the burn-outs in this cable was the fact that the cable had a higher apparent insulation resistance than any other cable in the subways, and would frequently on a test show an insulation resistance of over 4,000 megohms per mile a few hours before the occurrence of a burn-out. The same cable showed even a higher test at the factory, namely, about 20,000 megohms per mile. In the latter case it was tested with 400 volts. Burn-outs on this cable have occurred when the pressure employed on the circuit did not exceed 600 volts. The explanation of this may be that, owing to the nature of the insulating material and to the fact that it was not tested under water before being lead-covered, there may have existed fractures in the vulcanite tubing, or such fractures may have been caused in process of drawing the cable into the ducts. Under the tests made with the 100 and 400 volts E.M.F. of the testing battery, a fault would not develope; under the high electromotive force of the dynamo and the current of 10 or 12 amperes the fault would develope. This explanation is apparently confirmed by the fact that 25 miles of a somewhat similar cable, namely, the Cobb cable, which I have described, but in which paraffin is placed between the lead covering and the vulcanite tube, has been in successful operation in the subways for high-tension currents for over two months without any indication of a defect having occurred. It was rather unfortunate that the cable which I have said has been abandoned as unsatisfactory, and which has indeed been withdrawn from the subways, appears to have been the only cable used for electric lighting purposes in the New York subways which came to the notice of an English electrical engineer during a flying visit to this country, and a description of which cable he presented to our sister society in London in a recent Paper, with a favourable prediction as to its probable success.

Locating Faults.

No attempt is made to locate faults in electric-light circuits in the subways by electrical measurements, for the reason that the obstacles in the way of obtaining accurate data are so numerous that it has not been considered expedient to rely on the results of such measurements.

Durability of Cables.

Concerning the much-discussed question as to the relative durability of rubber compound and fibrous cables, I do not think sufficient time has elapsed in the case of the cables in the New York subways to enable one to arrive at a definite judgment. In the case of both types of cable, as I have already said, many circuits have been running continuously for over nine months, and in some instances for over one year, without a defect of any kind, electrical or mechanical, having occurred; and the slighter defects that have occurred on other circuits have as yet been so few in either type of cable as not to certainly show any marked superiority of one type over another. As regards the question as to which kind of cable will best withstand the heat from steam pipes adjacent to the subways, it would appear thus far that the lead-covered fibrous cable is superior to the homogeneous cable not lead-covered. Lead-covered rubber compound cables have not as yet been tried in the heated districts.

Multiple Cables.

There are no concentric cables in the subways in this city. The mains of multiple arc circuits are operated in separate lead covers in the same duct. It is contemplated, I believe, by some of the companies to use one lead cover for such circuits hereafter. One objection on the part of the companies to the use of concentric cables is the anticipated difficulty in making joints, especially where frequent connections for distribution are required. This objection should not hold good in the case of the feeder portion of the circuits. As to the use of multiple cables for electric lighting, one such cable, a fibrous cable having eight conductors under one lead cover, was placed in the subways, but has not been operated as yet, trouble having been found in making perfect joints. I have no doubt that with the experience since had in joint-making, this difficulty would be overcome; but it seems to be the general opinion that the use of multiple cables is not advisable in electric lighting. On the subject of loss due to increased electro-static capacity or to increased self-induction of conductors in the subways, I may say that I have made careful inquiry of superintendents of stations where the alternating current is used, and learn that no perceptible difference in the operation of the circuits as compared with similar circuits overhead is noticeable. I have been informed that in wet stormy weather a decided improvement is observable—in fact, that the condition of the weather does not affect the circuit. This will be the more readily understood when it is stated that a recent test, made during the prevalence of a drenching rain storm, of an arc circuit in the subways four miles in length, showed an insulation resistance of 2,400 megohms per mile. The lamp connections were disconnected from the cable proper during the tests, so that all the terminals of the entire cable were under cover except at the pole.

Joints.

When it was urged upon the electric light companies of this city that they were not using due diligence in placing their wires underground, the companies retorted that they were doing so as rapidly as possible consistent with good workmanship, and they cited the fact that it was not possible to joint up the cables more rapidly than was being done with the number of capable jointers at their command. To this an official of the city replied that this did not, in his opinion, constitute a valid excuse while so many poor men were idle who would be only too glad to be given work at jointing the cables. This was the view of a layman; but it would seem that in a number of instances in the electric light service in this country a similar view, namely, that any one could make joints and that any kind of joints might be made, was held by those who should be supposed to know to the contrary. In this city I think it is now fully recognised, by the electric light companies at least, that it pays to employ good jointers in underground work.

Several forms of joints are used on the electric light cables in subways. The Cobb people make a special joint somewhat as follows:—The ends of the conductors are spliced in the usual way, a hard rubber ferrule having first been placed over one end of the conductor, and a brass ferrule over the other conductor above the insulation. A machine like a double vice is then placed over the lead covering of the cable, and made fast thereto. A tightening device next draws the ends of the vulcanite together, taking up slack in the cable. The vulcanite sleeve or ferrule is then welded by heat to the vulcanite tube, after which the brass ferrule is drawn over the tube. A mould is then placed around the joint, into which molten lead is poured, thus casting a solid lead sleeve. This is quickly cooled by the application to the mould of cold water. The mould is then removed, and the joint is complete. This form of joint has been found satisfactory, I believe. The joint chiefly used on the Standard Underground Cable is made differently from the foregoing. After the conductor has been spliced as usual, and the lead covering has been cut back from the insulation, a few turns of tape are passed around the splice. A leaden sleeve is then put on over this and wiped firmly to the lead cover of the cable. When this has been done, a couple of small holes are punctured in the lead sleeve, through which a boiling insulating compound used in the manufacture of the cable is poured, filling up the sleeve completely, after which the holes are closed by solder. These joints have been found to give excellent service in this form of cable. The time taken in making this joint is about 30 minutes.

Lead-Covered Cable.

The cables used in the electric light service in the New York subways are, as I have elsewhere stated, without exception, lead-covered. The use of this lead covering is not required by the subway rules. In addition to being a protection against the attack of acids and gases, the lead covering is considered a safeguard against accidents to men working in the manholes among live wires. It will hardly be credited by some people, but it is a fact, that live electric light wires conveying the alternating high tension arc currents are handled and moved about in the manholes by means of the lead covering without the slightest indication that such wires are alive. In fact, it is quite a common occurrence to start up alternating circuits immediately after a rubber joint has been made, in order to save time, and then to have the plumber adjust and wipe the sleeve on to the lead cover while the current is in full operation. Another fact is this, that in the subways no shocks whatever due to induced current in the lead covering are felt by the workmen in handling the lead-covered cables conveying the alternating current. It is quite conceivable that such shocks might be noticed, as I believe they are, where the cables are suspended from point to point and insulated. It has been stated frequently that such induced currents, where the lead covering of the conductors is insulated, have been known to injure the lead covering, and eventually to destroy the insulation. So far as I have been able to ascertain, not in a single instance has such an action taken place in the subways. As a matter of fact, close personal observation and careful inquiry on all sides have failed to discover thus far any sign of deterioration in the condition of the material of the conduits, the lead covering of

Digitized by Google

the insulation, or of the insulation of the cables in the subways, with the exception of the effect upon the lead covering of the telephone cable in the creosoted wood conduit referred to. I may add that, even in the latter case, personal investigation and inquiry made of workmen have not confirmed the statement that the lead covering has been attacked. At all events, there is no evidence of any such wholesale manufacture of white lead as has been reported from other places where lead-covered cables have been placed in creosoted wood boxes.

Insulation and Tests.

The rules of the Subway Company require an initial insulation resistance of 15 megohms per mile per 100 volts electromotive force employed on the circuit, and a minimum of 5 megohms per mile per 100 volts. The initial test is made when the conductor is first laid in the subway, and prior to the turning on of the current. The minimum requirement is allowed after the circuit has been in use. This insulation requirement refers to the conductor proper in the subway, and does not include the lamps, aerial connections, or converters. The rule does not apply to conductors conveying currents of less than 100 volts E.M.F. In the case of alternating circuits, the uniform electromotive force employed in this city being 1,000 volts, the conductors to be employed in this service are required to show an initial insulation resistance of 150 megohms per mile, and a minimum insulation resistance afterwards of at least 50 megohms per mile. The average E.M.F. of the arc light circuits in the subways is about 2,000 volts, but in some instances it runs up to 3,500 volts. In the latter case the initial insulation resistance required by the rules is 525 megohms per mile; minimum, 175 megohms per mile.

It was at first thought by many that it would be impossible to maintain even the minimum insulation resistance required by the rules. One expert repeated the very common remark that one megohm, *if it could be maintained*, would be quite sufficient for practical purposes. I do not think this statement will be seriously contradicted, but the difficulty is to maintain the insulation resistance at one megohm in practice. Experience in the New York subways has shown that it is vastly easier to maintain the insulation resistance at 150, and even 500 megohms per mile, than it has been in the past in other cities to maintain them at one megohm per mile. A gentleman writing of the Chicago underground system, not quite two years ago, remarked: "It was found that although the insulation measurement of the lead-covered cables in the conduit was very high, considerably above a megohm, a short circuit would form, generally within 1,000ft. of the station, between the two sides of the circuit. The explanation for this short-circuiting under such conditions would appear to be simple, namely, that if the insulation resistance of a conductor is but one megohm per mile, the covering being of the ordinary thickness, it is clear enough that it is decidedly inferior insulation; and if the normal insulation resistance of the conductor is very much higher than one megohm per mile, but the measurement nevertheless shows it to have an insulation resistance of but one megohm, it is or should be sufficient evidence that a fault has developed in the insulation which surprises no one when it produces a short-circuit or burn-out.

As I was in no wise responsible for the subway rules, modesty need not restrain me from saying that experience of over a year has amply proven the wisdom of those requirements. For these requirements not only necessitated the use of an insulating material possessing high specific insulation, but also compelled the exercise of the greatest care in the details of placing the conductors in the conduits, in the making of joints, &c. When it is stated that these conductors are jointed at every manhole, and in many instances at several places between manholes, the need of such carefulness in order to maintain a high insulation will be understood. If, for example, the method of making joints that was employed some years ago in Philadelphia—namely, to strip the ends of the lead covering for two or three inches and then to place three or four turns of tape around the ends of the conductor—had been followed in the New York subways, I make no doubt I would have had to report to-night a continued series of failures in the electric light service similar to those so often quoted as having happened in Philadelphia. I am confirmed in this belief by the fact that the first electric light conductors laid in the New York subways were found to possess an insulation resistance of but little over 100,000 ohms—this, notwithstanding that the insulation resistance of the conductors at the factory was over 2,000 megohms per mile. There were about 40 joints in these conductors. Where these had been cut out and new ones made by an expert jointer the insulation resistance rose to over 1,500 megohms per mile, and a very recent test of the same circuit shows it to possess virtually the same insulation resistance.

The high-tension electric light conductors are tested weekly for insulation resistance. The tests are made by the direct deflection method, a Thomson reflecting galvanometer being used, and, as a rule, a 100-cell chloride of silver battery is employed as a testing battery. The tests are generally made from some room or basement adjacent to the terminals of the conductors in the subway, in order that the subway portion of the circuit may be tested exclusive of aerial portions. The subway conductors are, as a rule, tested exclusive of arc lamps, converter, and inside wiring, but frequently also the tests are made inclusive of arc lamps and converters. These latter tests are only accepted when the results fairly indicate that the fall of insulation is due to the lamps or converters. In quite a number of cases the tests with converters included show an insulation resistance up to the requirements. Tests of circuits are not made inclusive of house-wiring, because of the generally low results of trial tests. Some such tests that I have made showed an insulation resistance of the house wiring of less than 1,000 ohms.

The following record of actual tests may be of interest:—

Circuit A, Arc. Initial test, 588 megohms per mile. Last test of same circuit, 388 megohms. Present length of circuit, 9·5 miles.

Circuit B, alternating. Initial test, 141 megohms. Last test, 1,250 megohms. Length, 9·6 miles. The first test was made when circuit was much shorter than at present, and, doubtless, the terminals of conductors were exposed during that test.

Circuit D. Initial test, January 6, 1889, 224 megohms per mile. Length of circuit, 4 miles. Subsequent test, January 2, 1890, 484 megohms per mile.

Circuit E. January 4, 1889, 1,750 megohms per mile. Same circuit, January 4, 1890, 1,516 megohms per mile. Length, 1 mile.

Circuit F. July 7, 1889, 264 megohms per mile. January 3, 1890, 343 megohms. Length, 6·6 miles.

The readings for these tests are generally taken after one or two minutes' electrification.

Tests with converters included in some cases show very fair insulations. One circuit with 34 converters included showed 11 megohms total insulation resistance. Another with 11 converters included gave a total insulation resistance of 159 megohms. It is not uncommon to get an insulation resistance of from two to five megohms with 30 and 40 converters in circuit. These tests did not include aerial portions in circuits. It should be said that the insulation of the converters and connections is being constantly improved, and, in my opinion, the time is not remote when the underground circuits will test up to requirements at all times with converters included.

Contrary to the expectations of some people, the actual making of these electrical tests has not been attended with any serious difficulty. The most troublesome factor has been that due to surface leakage at the battery or other parts of the testing equipment, during the very humid weather which prevailed so continuously last summer and winter. The time for making these tests is as far as possible chosen to suit the convenience of customers. The majority of the tests are now made in the early mornings. All circuits are tested once a week at least.

About 130 miles of the subway electric light conductors referred to are employed as carriers of alternate current for incandescent lighting; about 60 miles as carriers of arc light, and incandescent continuous currents. The circuits vary in length from one mile to eleven miles; the longest arc light circuit is 10 miles in length—the longest alternating circuit is 11 miles in length. In 10 miles of alternating or arc circuit there are from 450 to 500 joints. The greatest number of converters on one subway circuit is 65. There are 14 arc light circuits and 25 alternating circuits in the subways. Quite recently an alternating arc circuit has been installed in the subways which is intended to be the pioneer of numerous such circuits. I may say that it is ultimately intended to operate at least 125 arc lamps in such circuits.

Lightning Arresters.

In the case of many of the electric light circuits that were first laid in the subways of New York city, lightning arresters were used at street lamps and at the terminals of the cable, and in a number of instances the same apparatus is still used. These "arrestors" are those known as the Acheson cable protector (*Electrician*, September 21, 1888, page 630), and are intended to protect the cable against disruptive discharges from any source. The utility of this device for the purpose intended has yet to be demonstrated in this city, inasmuch as the frequency of burn-outs in unprotected cables in the subways has been no greater than in those which are equipped with the protector, the percentage of burn-outs on cables in either case being, as I have before intimated, very low. It is as yet, I think, an open question whether the use of this or any equivalent device is warranted. There is no record of any of the cables in the New York subways having received injury from lightning during the past year.

It is commonly supposed that the freedom from burn-outs which the successful electric light cables in the New York subways have enjoyed, as compared with the earlier experience of other cities, is

Digitized by Google

due to an increased thickness of insulation around the conductor. This may be the correct explanation; but the fact is worthy of attention in connection with this subject, that certain electrical condensers have for years been placed in positions where they are exposed to the full effect of lightning discharges on telegraph lines, without in a single instance having sustained injury therefrom. Similar instruments have also been placed across the poles of 1,000 volts alternating dynamo machines for days without perceptible harmful effect. Since it is difficult to imagine a better opportunity for a disruptive discharge to effect its escape to earth than that presented by the extremely thin tissue paper used in those condensers, the thought is suggested that if this paper can be so constructed as to act as a barrier to the passage of such charges there may be more to be considered in this matter of insulation than the mere question of thickness of the insulating material.

Alleged Dangers of the Subways.

The dangers to be apprehended from the existence of the electrical subways and from the placing of the high-tension wires therein, according to those who are perhaps more or less inimical to that action, are varied. In general terms they say that the dangers which menace the public and *employés* from the presence of wires overhead will be multiplied manifold when the wires are underground. But, when asked to specify those dangers, the reply is limited to the following, namely:—first, that linemen will be killed by coming in contact with live wires in the manholes; second, that high-tension currents will leave the subways and enter buildings by way of water and gas-pipes, &c.; and, third, that accidents due to explosions of gas in the subways will be numerous.

As regards accidents to workmen in the manholes, due to contact with live wires, no one will say that such occurrences are impossible; but inasmuch as not a single accident of this kind has occurred in New York City, or, so far as I can learn, elsewhere in electrical subways, it is fair to assume that, with the exercise of proper supervision of the wires, this is not likely to prove a frequent source of accident. I have already suggested in another place that the fact of the wires being metallically covered may have conduced to the immunity from accidents which the workmen in the manholes have enjoyed. I may interpolate here that it is recognised that the efficiency of the manholes would in many instances be increased if they were larger; and, wherever the surrounding condition of the street will permit, it is, I believe, contemplated to enlarge the manholes.

So far as the statement is concerned that danger is to be apprehended by the entrance of powerful currents into buildings by way of water and gas pipes, by contact of a grounded conductor in the subways, it would scarcely be worthy of notice before a body of electricians, but for the persistency with which it is said to be urged by men of prominence in the electrical profession. It is conceivable that if a conductor, within a building, should by accident come into contact with a well-insulated gas pipe also within a building, one might receive a shock by contact with the gas pipe if in some manner he should complete the circuit; but in what manner, in the event of a ground in the subways, any dangerous current can be conveyed to the inside of a building by means of gas and water pipes which have the entire area of the city's foundation as a ground or return circuit is more difficult to understand.

Gas in the Subways.

In my opinion the presence of gas is the most serious defect of the electrical subways in cities; of course, it is not an inherent defect in the subways, but it is nevertheless a very troublesome one, not only because of the danger of explosions therefrom, but also because of its ill effects upon workmen employed in the subways. As previously remarked, the ducts used in the subways are not only joined together as nearly hermetically as possible, but, except in the case of distributing ducts, they are laid in a solid body of cement from manhole to manhole. It is supposed that the gas obtains ingress to the manholes through the place where the iron manhole cover rests upon the masonry of the manhole. But at whatever point the gas enters the subways, its unwelcome presence is acknowledged; and while it is self-evident to any one who will investigate the matter for himself, and is actually admitted by the gas companies that the gas emanates from the gas mains in the streets, nevertheless the subway engineers have been constantly at work devising means to remove the intruder. To this end various methods for ventilating the subways have been suggested and tried, the most successful of which thus far has been the ventilation of the subways by the use of blowers stationed at intervals along the subways; and arrangements are now in progress to place fifteen such blowers in operation to cover the entire subway system. As the ducts become filled with cables, however, the free passage of air through them is prevented, and in this way the utility of the blowers is diminished. In order to evade this difficulty a 6in. wrought-iron pipe has been laid above the subway ducts in the more recently constructed subways. This large iron pipe has openings at each manhole. The openings are graduated as to their extent as they recede from the source of the air pressure. The larger openings are at the points remote from the blower. It is intended by the use of these large pipes to furnish a counter-pressure in the subways somewhat exceeding any tendency of a pressure from the outside—rather than to produce a strong current of air through the ducts, and in this way to prevent the ingress of gas through any crevices that may exist in the subways.

It has been frequently suggested that good results might follow a suction method of ventilation; but experience has shown that this would rather aggravate the evil, as it would draw into the subway all the accumulated gas in the streets, besides inviting a large leakage from the gas mains. The only beneficial effect to the subways of this resort to blowers to drive out the gas is that the air dries up the ducts and manholes within quite a distance of the blowers.

The cause of these explosions in the subways has not in every case been definitely located. It is, of course, known that they are due primarily to the ignition of an accumulation of illuminating gas mixed with atmospheric air in the explosive proportions, but the difficulty has been to ascertain by what means the gas has been ignited. It is on record that these explosions have occurred in sections of the subways in which there were at the time no wires whatever. And in cases where there have been live wires in the vicinity of an explosion, tests made immediately after the event have shown that those wires were in practically perfect condition as regards insulation. There are but three instances on record in which a defect in an electric light cable has occurred simultaneously with an explosion in the subways; and in one of these cases the defect occurred so nearly incidentally with the explosion that while it is quite possible that the defect may have caused the explosion, it—the defect—may have been due to mechanical injury due to the explosion. Among other theories it has been suggested that the gas may be ignited by currents induced in the lead covering of alternating current conductors. This might be the case if, as I have before suggested, the cables were supported from beam to beam, as on a bridge, on insulated stands, and if the lead coverings only approached each other at intervals; but where the lead coverings of the conductors are not only grounded throughout their lengths, as in the subways, but are also joined metallically—in fact, are practically one cable in the ducts—it seems unlikely that a quantity of induced electricity, sufficient to produce a spark, could be accumulated at any one point. At all events, no sparks are observable in the subways at any time; and, as I have already said, there is no evidence of the generation of such charges manifested by the handling of the lead covering of the cables.

In the case of at least two explosions in New York City, the evidence showed that the gas in the subways had been ignited by a lighted lamp or match in the vicinity of some subsidiary duct connecting with the subways; in other instances by a match or lighted cigar thrown in a manhole. It is known that in Chicago an explosion was caused in the subways by a live coal from a passing fire engine falling upon the cover of a manhole. With but one or two exceptions, the explosions have not injured the cables in the subways, which is probably due to the small and round surface which the cables present.

It has frequently been suggested that if solid ducts were employed instead of tubular ducts these explosions would be avoided. While this would be, if correct, a strong argument in favour of solid conduits—that is, ducts in which the conductors are not removable, notwithstanding the generally admitted fact that such ducts are not practicable for subway work on a large scale experience has demonstrated that explosions have occurred repeatedly in manholes and in small junction-boxes of subway systems in which there were no hollow ducts. I may add that, pending the installation of blowers in certain of the subways, men are employed day and night opening manholes to permit escape of gas. I had intended to comment briefly on the comparative expense of maintenance and reliability of underground wires in cities as compared with overhead wires; but as my Paper has far exceeded the limits which I had placed upon it, I shall leave that and other features in abeyance for the present.

The following are some of the rules of the subways of New York City which have been promulgated as precautionary measures or as a result of actual experience.

No bare ends or bare portions of conductors, whether in or out of service, are permitted in the manholes. No joints, except such as are protected by a metallic covering, are permitted in the manholes. All conductors in manholes are required to be arranged symmetrically around the walls and to be plainly tagged with the designing mark of circuit and the name of the owner. No switch-boxes are allowed in the manholes.

In conclusion, I think it may be said that the experience derived from the practical operation of the electrical subways of New York City has either made apparent or confirmed, among other things, the following:—

That it is possible to successfully operate all classes of electric conductors underground in cities. That, at least for conductors conveying high-tension currents underground, it is advisable to set

Digitized by Google

the standard of insulation high. That regular insulation tests of the conductors are very valuable. That liberal thickness of insulation is desirable for high-tension currents. That it is unadvisable to place under ground new types of cable or insulation until they have been subjected to tests and conditions analogous to those to which they will be subjected underground. That for electric light conductors—especially distributing mains—many conductors under one cover are not advisable, owing chiefly to the difficulty in making joints in such cables. And lastly, that while other features may be accessories thereto, the employment of smooth, strong conduits, accessible ducts for distribution of the current, first-class insulation, constant expert attention to details, and thorough organisation in every department, are essential to the production of a successful electrical underground system.

NINE YEARS WITH THE ARC LAMP.*

BY M. D. LAW.

The subject of this Paper is one that is of interest not only to every central station man, but also to those who handle arc lights in isolated plants; and if I can give you but one point that is of value I shall feel amply repaid for my labour. There are a large number of irregularities in arc lamps that can be remedied by a judicious study of their actions; and, after the cause of their trouble has been found, it should be remedied even if the lamp has to be rebuilt.

In order to find the special trouble that arc lamps are subjected to, a careful record should be kept of each and every lamp. To do this, give each lamp its individual number; then, by the use of a numbered book, allowing a page for each lamp, a record may be kept of all lamps, where they are, when changed, with the kind and amount of repairs. This method of keeping a lamp record allows of finding the peculiar trouble that the lamp is subject to. If a lamp is continually being changed for the same cause, there is some one thing that is radically wrong, which is causing the trouble; this should be found and rectified. For instance, a lamp may work perfectly on the test rack, but after being in use for a short time, would have to be changed for dropping. If from the records of that lamp this is found to be its general complaint, then look for the trouble, if a Brush lamp, in the winding—that is, there may not be the proper resistance of wire on the magnets, or there is too great a difference in resistance between them, which should not be more than one ohm, or the result is a side-puller. The resistance of the magnets should be kept as near as possible to 85 ohms; never allow more than three ohms variation from that amount. Binding of the mechanism, large washers, or too high adjustment of the arc, will cause dropping. In hunting for the cause of this trouble in the Brush lamp, I found that, with proper construction, it could be made to work without dash-pot or spring, better than the old style with dash-pot and spring. I assumed that in a differential magnet there must be a point of equilibrium between the two magnetisms, and that, if the cores were accurately suspended at the centre of this point, any variation of current would affect the core quicker if so suspended than if it were forced to or from that point by a spring; this I have found to be the fact.

Another point wherein expense is saved in the Brush lamp is in the winding of the cut-out magnet. Divide the magnet in two parts by an extra fibre-head, and by winding the fine wire at the top, with a resistance of 15 ohms; the coarse wire can then be wound on at the bottom, allowing the end to make connection with the cut-out armature at least half an inch from the head of the magnet; this will reduce the chances of burning out. If there is a bad contact when the lamp cuts out, even if it does burn out, only one wire will have to be removed. If the following rules are strictly adhered to in the putting together of a Brush lamp, it will be found to burn correctly with but little adjusting:—

See that the upper carbon-holder is in line with the rod. This adjustment is very important, and is made by clamping a steel rod of the same size as the carbons to be used in the holder, and revolving it between the thumb and the finger, noting whether the lower end of the testing rod revolves on its own axis or "wobbles." In the latter case, push the holder up to the lamp box, and, by means of the testing rod, bend it slightly in the proper direction to correct the error, then see that the carbon-holder has not become loosened; test again, repeating the process until the desired adjustment is reached.

Examine the lifting washers which surround the carbon rod; see that the hole is counter-sunk on each side, so as to make the available thickness of the washer where it touches the rod but little more than one-sixteenth of an inch. See that the hole in the washer is of such a size that one side of the washer may be raised one-sixteenth of an inch from the horizontal floor on which it rests, before it clamps and commences to lift the rod. See that the holes in the washer and bushings are nicely polished. The lifting finger, designed to lift the washer, should move freely in its guide and get a good hold under the edge of the washer, and allow the latter to rest flat on the floor under it when the finger is down. In the case of double lamps, the lifting finger should be so adjusted as to lift the second rod one-sixteenth of an inch ahead of the first.

See that the movable brass parts connecting the lifting finger with the movable magnet cores work freely at their joints, so that no binding of the parts may be possible. The spring which partly supports the magnet cores should be made of steel "pianoforte wire," twenty-seven thousandths of an inch in diameter, wound closely over a mandrel of such size that the spring when released shall have an external diameter of seven-sixteenths of an inch, and shall consist of about 38 turns of wire exclusive of the hooks at the ends. See that all the parts of the dash-pot are free and do not bind. See that the armature of the cut-out moves freely on its pivot, and when it is down its end is about one-quarter of an inch from the core of the cut-out magnet; and when it is raised and makes contact with the copper wire projecting from the cut-out magnet, that its end comes about three thirty-seconds of an inch from the cut-out magnet core. The brass spiral leading from the cut-out armature is not used as a spring, but as a resistance. It must be pulled out or pushed together as the case may require, that it shall exert neither a lifting nor depressing influence on the armature. This spiral is made of brass wire twenty nine-thousandths of an inch in diameter and about 30in. long before being coiled. The size of this wire is important, as it should be of just right resistance, that the lamps may cut in when the carbons come together; for this same reason the armature is not allowed to come close to the core of the magnet, but should be made to come as close as possible that a better contact may be made, thus reducing the liability of burning out.

The principal improvements that can be made in the Thomson-Houston lamp are the making of the clutch of German silver or some more durable metal than brass, as the bearing point of the clutch against the rod is so small that it very soon wears, and thus throws the lamp out of adjustment. When one of these lamps is found dropping, it can very often be remedied by lowering the adjusting nut No. 692 a trifle, when the lamp will again burn correctly, and, in some cases, this may be repeated several times without any other change in the lamp.

Another great point of improvement in this lamp is increasing the thickness of the insulations, which are too small in nearly every case; especially is this the case with those under the binding hooks at the top of the lamp box, which I find work excellently well when made of porcelain. When the insulator in part No. 701 gives out, the current shunts through the cut-out magnet, causing what the men term "cut-out armature magnetised." This is a very important point, which produces flaming and dropping.

The general causes of the Thomson-Houston lamps dropping are numerous; but if all the working points move freely and without lost motion, it will reduce the number to the few following points:—Badly-worn spots in the carbon rods; the clutch or lifting springs may have lost their temper (these should be made of bright instead of black steel); bent clutch arm; worn clutch or carbon rod bushings. The adjustment nut No. 692 may be too high; the clutch or tension spring may be too tight. Crooked frames, bent rod or rods striking the chimney, tight bushings, fine wire broken, dirty rods, or the adjustment nut No. 692 being too low; brush in the bushing may be too tight or become corroded or burned, and the magnetising of the armature before spoken of will cause the lamp to flame and drop.

The globe-holder or carbon-holder of the arc lamp is a very much neglected part—that is, the insulations are not made heavy enough, and the carbon dust or copper droppings falling over the insulations will give sufficient leak for a person standing on the ground and touching the bottom of the lamp to receive a very bad shock; this insulation should be made heavy and so placed that the carbon dust may not fall on it, as it is sometimes impossible to hang lamps under awnings high enough but that, when a person passes under them, they may be touched by any conductor which they may have in their hands. No part of the lamp outside of the globe should be allowed to have current in it. Arc lamps should be suspended by some perfect insulator, the regulator porcelain insulator and hook being the best in our experience. Never allow crocus or emery to be used, as it badly wears the rods in the centre. A better plan is, if the rods become rough or dirty, bring the lamp in and polish on the buffing-wheel, which will allow of its being kept of an even size its entire length.

The longest record for any one lamp in a constant street service is three years and nine months, without any adjustment other than the ordinary cleaning by the trimmer.

The most vexatious part of the arc lamp is the globe; it swells the item of expense in spite of the utmost care, besides being a

* Read before the National Electric Light Association, at Kansas City, February, 1890.

Digitized by Google

great source of complaint; for I never knew one to be well enough cleaned but there would be a complaint that it was not polished. Undue heat after the carbon has burned close to the holder is one of the greatest causes for broken globes. This can be partially overcome by leaving the globe about one and a-half inches from the carbon-holder.

The waste in the use of carbons is a very important feature. These should be dealt out, and every stump returned; the amount saved in laying by the four and five-inch stumps, to be used in the summer months, will make a saving of at least ten thousand carbons per year for a one-thousand light station. At the time I first started dealing out carbons and bringing in stumps, I saved on an average over thirty dollars per month, and then only trimming about four hundred lamps per day.

While I am a great believer in the use of the best quality of insulation for line construction, yet it is not best to depend entirely on such insulation for safety. Put up the best wire there is, and then apply a rigid system of inspection and tests, not by that abomination of tests, the magneto bell. Not only should the tests be made on dead lines, but should be made at least once in two hours on all live wires, and when grounds or bad leaks are discovered they should be immediately cleared, by that means preventing the second ground, which is the element of danger. I have repeatedly had lines that would test clear at the time of putting on circuits; but two hours after solid grounds have been discovered, located, and found to be wires broken down, hanging over the electric light wires and reaching down to the sidewalk, where they are a source of danger to every passer by. All lines should be cut by one man, who is especially instructed and detailed for that work, as then you are enabled to pick out a thoroughly reliable man and drill him in the work that he is to do; then, by never allowing a circuit to be opened, and teaching all men to never depend on any insulation, but to treat all wires and lamps as if they were charged with an electric light current, danger to *employés* will be reduced to a minimum.

Supplementing the Paper, Mr. Law said:—Another point to which I would like to call your special attention is in the matter of testing arc light lines. It has only been within the last six or eight months that we have been putting a thorough test to line wires. I can now positively locate a ground at the station before leaving to hunt it up. These tests are made at regular intervals of about two hours during the night and day on all live circuits. As soon as those grounds are discovered my foreman is notified and I also receive notice myself, and the proper men are detailed to remove them as soon as possible.

The manner in which I have been testing grounds at our station for the past year or eighteen months is by the use of a set of incandescent lamps in series; that is, I use 47-volt lamps for a 60-light machine; these lamps are put up out of the way and a wire run from each one of these lamps to the switch plate. There is a lever arranged to turn around in a circle, making a short circuit of one, two, three, four, five, &c., to cut out one or all of these lamps. Now, if a wire drops down on an electric wire grounding it, the distance which that wire is away from the station is simply a measure of potentials. Every two hours we test each one of our circuits in the first place by testing across the circuit. The number of incandescent lamps then burning up to 48 volts indicates the number of lamps that are actually burning on the circuit, less the resistance of line, which I find amounts to about ten miles of number 4 wire for every arc lamp; then we test by placing one side of the incandescent circuit to ground and the other side to line; then by turning off my incandescent lights until I bring the voltage up to 47, I find a certain number of lamps burning. We will say ten lamps on the positive side; now I turn my attention to the negative side and go through the same operation. If I find that I have fifty lamps on the negative side, I know that the ground is ten arc lamps away from the station on the positive side, and if your circuit books and diagram books are correctly kept, you can tell in two or three moments' time exactly the location of that lamp. In 99 times out of 100 we go to the right lamp.

BOOKS, &c., RECEIVED.

"Electrical Engineering." By W. Slingo and A. Brooker. (London: Longmans, Green, and Co.)

"Aide-Mémoire de l'Ingénieur-Electricien." By MM. G. Duché, B. Marinovitch, E. Meylau and G. Szarvady. Second Edition. Enlarged and revised, by M. P. Juppont. (Paris: Bernard Tignol.)

"*Journal* of the Institution of Electrical Engineers." Vol. XIX. No. 84. (London: E. and F. N. Spon.)

"L'Année Électrique." By Ph. Delahaye. Sixth Year. (Paris: Baudry et Cie.)

"Annual Report of the Canadian Institute." Session 1888-9. (Toronto.)

THE HEYMANN DYNAMO REGULATOR.*

In a patent recently issued to Edward and Frank W. Heymann, of Boston, the inventors describe a method of dynamo regulation which is based upon controlling the electromotive force in the armature coils by means of a shunt circuit so arranged as to act by induction upon the armature coils, a variable resistance in that shunt circuit being adjusted from time to time to regulate the differences of potential between the terminals of the work circuit.

As shown in the accompanying illustrations, the regulation coils C C′ are in the shunt circuit, *b* C C′ *b*′. When at full load, the resistance R is so large that the shunt circuit *b* C C′ R *b*′ (Fig. 1) is practically open, and there is little or no current in that shunt circuit. If one of the lamps, L, be switched out, the current in the work circuit B L F F B′ will tend to increase. But if the resistance R in the shunt circuit be reduced, the current in the work circuit will be thereby kept constant, for the reason that the

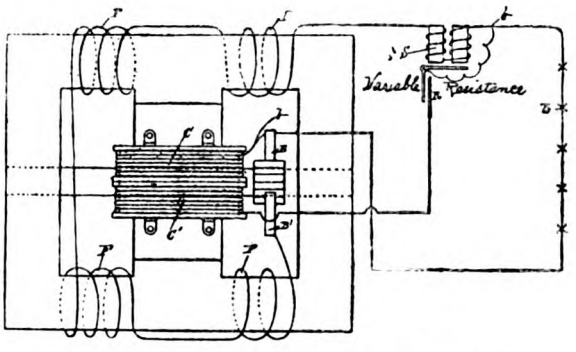


Fig. 1.—The Heymann Method of Dynamo Regulation.

current through coils C C′ will so reduce the electromotive force of the armature coils as to make the difference of potential between the brushes B B′ suitable for giving the desired current in the work circuit. Consequently, if the resistance R be reduced whenever the resistance in the work circuit is reduced, and in the proper proportion, the current in the work circuit B L F F B′ can be maintained constant, and this with proper economy for practical purposes.

In the case already described the difference of potential between the brushes B B′ or between the junctions *b b* requires to be varied in order to keep the current constant, in spite of variations in the

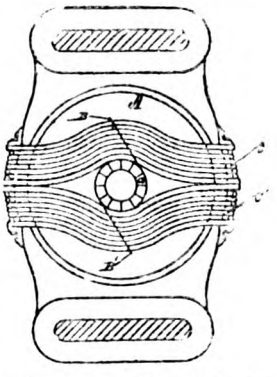


Fig. 2.—The Heymann Method of Dynamo Regulation.

resistance of the load. In case of a constant-potential machine, however, the object is to keep the difference of potential between the brushes B B′ constant, whatever the resistance of the load, and consequently the current may vary. In this case, under full load, the resistance R in the shunt circuit *b* C C′ R *b*′ is at the maximum, as before; but when one lamp is cut out the resistance of the load is thereby increased, and the tendency is in that case to increase the difference of potential between the brushes B B′; but that difference of potential can be maintained constant by decreasing the resistance R as the resistance of the load is increased.

It will be seen that the shunt circuit *b* C C′ R *b* is not a mere shunt—that is, as if the regulating coils C C′ were not present—for if the coils C C′ were absent the current through *b* R *b*′ would be considerably more than it ever would be through *b* C C′ R *b*′. That is to say, the coils C C′ regulate the electromotive force of the coils of the armature and also set up a counter electromotive force, which not only lessens the current through *b* C′ C R *b*′, but also regulates the difference of potential between the brushes B B′.

* From the *Electrical World*.

Digitized by Google

THE CITY OF LONDON AND SOUTHWARK SUBWAY RAILWAY.

This Bill, which asks for powers to extend the above railway to the "Plough," Clapham, came on for hearing on Tuesday before a Committee of the House of Commons, consisting of Mr. Walter James (Chairman), Mr. Esslemont, Sir Richard Temple, and Sir Edward Grey.

Mr. J. H. GREATHEAD, engineer to the line, in examination by Mr. RIGG for the promoters, said:—With the electric locomotives they now had they could run at a speed of 25 miles an hour between the stations, and they could get an average speed from spot to spot of 20 miles an hour, and probably, including stoppages, of 15 miles per hour. They had made successful trial trips on part of the line between the City and Great Dover-street and the Elephant and Castle, with electrical locomotives and carriages weighted to the full load of three carriages.

Dr. JOHN HOPKINSON felt certain that the proposal to work the City and Southwark line by electricity would be attended with perfect success. The dead weight to be driven for every passenger being two-thirds less on the Subway than on the Metropolitan Railway, and also the load on the generating machinery being much more uniform in the Subway, he had no doubt whatever that the amount of coal burnt for every passenger carried when the trains were fully loaded would be much less in the Subway than on the Metropolitan Railway. There would be no disturbance to telegraphs or telephones. The railway was entirely enclosed in a tube of iron which would conduct away any leakage currents. The actual power used would amount at times to over 100 horse-power on each locomotive. At Newry there was only one dynamo machine upon the motor car, but in this case there would be two, generating 50 horse-power each. The gross weight of a train in the Subway would be 29 tons loaded and 22 tons unloaded, and the maximum speed 25 miles an hour. The tractive force of the locomotive would be about 3,000lbs. at its maximum.

Cross-examined by Mr. POPE: No doubt the current would be generated more economically at Stockwell for the whole of the line than for part only—that is to say, that which was generated at Stockwell would be applied to the extension. The generating station would be more nearly approximating to the centre of the line.

Cross-examined by Mr. ERSKINE POLLOCK: The tension of the current passing along the conductor would be about 500 volts. It would not be dangerous to life.

The further consideration of the Bill was then adjourned.

PARLIAMENTARY INTELLIGENCE.

HOUSE OF LORDS.—FRIDAY, MARCH 15TH.

The DUKE of MARLBOROUGH rose to ask Her Majesty's Government what steps it was intended to take this Session with regard to appointing a House of Lords Committee to carry on further the investigations of the House of Commons Committee of 1885 on the subject of telephone wires and communications; and to inquire whether Her Majesty's Government had any intention, on the expiry of the English telephone patents, to take up, under the direction of the Post Office, the extension of the telephone system in this metropolis and between large towns, and provide those advantages to the public and to private customers at a cheap rate; also whether, in the case that the proper organisation of such a system should appear to the Post Office authorities to be too large an undertaking, entailing a large initial expenditure and considerable organisation, whether Her Majesty's Government intended to give better facilities than had been heretofore obtainable to any public company or companies for carrying out this much-needed requirement. The questions really had reference to the motion which he had brought forward last year when he asked what the intentions of the Government were with regard to the telephones of the country. He thought the feeling was pretty general that the telephone was one of those valuable inventions as to which they ought to have an inquiry. In order to develope the telephone system in London a very large expenditure of capital would be required. No company, he thought, ought to start short of a million of capital. It therefore became a question whether Her Majesty's Government would recommend an expenditure of so large an amount to establish an organisation quite as important as the Post Office. This was a question for the Government to consider. The Postmaster-General had the power of running wires where he pleased as long as no damage could be proved to result, and without that power it would be impossible to have a system of telephones for London. If the Government were to depute the telephone system to public companies, had they the right to concede the power of running wires, and were they prepared to concede that power? Again, if there were to be public companies was there to be public competition? If there were, the competition would have to be limited to two companies at the most. Otherwise the benefits of the system would be greatly depreciated by persons wishing to communicate with each other being attached to different companies. Moreover, to have many companies would lead to indiscriminate wire running, with results as confusing as had been experienced in New York. Again, if the telephone system were deputed to public companies there was no doubt that the telegraph would be largely superseded. It would not be right for the Government to burke a great invention merely because it interfered with the telegraph system which they had taken over; but it was in the power of the Government, without doing this, to protect themselves. The telephone system was worked at a great profit, and therefore the Government would be justified in charging very high royalties and in conceding the powers which the Postmaster-General possessed, while they might keep in their own hands the main trunk lines between great towns. This would prevent the telegraph receipts from falling off unduly. The telephone would undoubtedly interfere with municipal telegraph receipts, but protection could be found in the royalties. He therefore asked whether Her Majesty's Government thought it would be advisable to have a Committee to inquire into the question of overhead wiring, and whether the Post Office should adopt the working of this great system of telephones; whether Her Majesty's Government would be prepared, if they decided not to take up the question, to grant to public companies the right which the Postmaster-General now possessed; and whether they would refrain from granting those rights to more than two companies.

Lord BALFOUR said that all would agree in the great importance of the subject now brought forward, and all would be equally unanimous in the desire that no undue obstacles should be in any way opposed to the development of the telephone system for the convenience of the public. The questions of a kindred nature which the noble duke brought forward last Session were somewhat different from those now raised, involving as they did questions of electric lighting overhead wires, as well as a considerable scheme for amalgamation. The noble marquis at the head of the Government then said that he did not think it was a desirable subject for inquiry by the House, and now he had to repeat that view of the matter, but with a stronger reason. Some patents of great importance would expire at the conclusion of the present year, and he was authorised to say that the relations of the Post Office with the telephone companies were at present under the consideration of the Government. This involved large questions of private right, and therefore it was not very desirable that at this stage of affairs the matter should form the subject of investigation by a Committee. The more usual and proper course would be for the Government first to make up their minds as to what proposals should be placed before Parliament, and that Parliament should express its opinion on those proposals when submitted. Therefore he hoped that the noble duke would not press for an inquiry by a Committee of their lordships' House. With regard to the first clause of the motion, there was not, of course, absolutely the same objection to the inquiry. But in the circumstances of the case, and remembering that the matter was inquired into by the House of Commons in 1885, he would express the general opinion that it was undesirable to reopen the question at the present time. He was far from saying, however, that the whole question was thoroughly threshed out by the Committee of the other House, and undoubtedly considerable confusion existed as to the exact state of the law. If the noble duke pressed for a committee of inquiry, and would put the exact terms of the motion of reference on the paper, the Government could promise to give it the most careful consideration.

The DUKE of MARLBOROUGH said that as to the difference between the present motion and the motion of last year, he wished to avoid any question of electric lighting wires, as they were a proper subject for the Board of Trade to deal with. Undoubtedly, until Her Majesty's Government had expressed their intention with regard to the present companies it would be inadvisable to inquire into the development of the telephone system. But with regard to the running of overhead wires, he thought that the report of the House of Commons supplied complete information. He would press upon the Government the great desirability of intimating as soon as possible the line of conduct which they meant to adopt, and they should also state whether they meant to give powers to public companies, and, if so, under what conditions. He would, therefore, withdraw the motion which stood in his name.

CORRESPONDENCE.

ELECTRIC TRACTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Reckenzaun, in his criticism on my letter, seems to have lost sight of the fact that I was dealing with a particular case, viz., that of the Barking-road line. This will explain my having included drivers' wages in my estimate, as this item was there included in the expenses undertaken by the Traction Company, though I am aware this is somewhat unusual. As to the figure I gave for these wages, ·6d. per car mile, as I explained, I put everything down at the lowest possible figure. At the same time I may point out that I gave the Traction Company the benefit of supposing that they were capable of something better than 70 miles per car per day (decidedly a low mileage for a mechanically driven car); and that, on the other hand, we should probably never have heard so much of "slavery" on the tramways if drivers were usually paid at the rate of 6s. a day, as Mr. Reckenzaun thinks they are.

The difference between the two estimates for the cost of steam power is also to a great extent to be explained by a similar consideration. Mr. Reckenzaun takes as his basis an engine of 200 horse-power. On the Barking-road, where five

Digitized by Google

cars at the most are running, an engine of one-third of this capacity would be sufficient, and of course the cost of power would be considerably higher.

But, after all, the principal point on which we are at issue is as to the cost of renewal of accumulators. I put this at 1½d. per car mile as a minimum; and Mr. Reckenzaun asserts that 1d. will leave a handsome profit, "a most desirable business for anyone who understands it, whose works are not hampered with a huge capital, plus debentures, and whose administration and office expenses can be kept considerably below £10,000 per annum." But why should a profitable business not be desirable for anyone with a large capital and heavy expenses? Surely it would be all the more desirable, and, if so, why is it not undertaken? There would be an ample field for it, as it would greatly simplify the introduction of electric traction, and I do not think that the Electric Traction Company would at the present time be above considering an offer for the renewal of accumulators based on Mr. Reckenzaun's estimate.

The fact remains, that in spite of numerous attempts, in no single case has traction by accumulators on a practical scale for any length of time in England, America, or on the Continent, been found sufficiently profitable to warrant its continuation; and until something like 1d. per car mile for renewals gets beyond the paper stage, I do not see how any system using accumulators can become a commercial success.—Yours, &c.,

Wimbledon, March 18, 1890. H. J. S. HEATHER.

THE "FEEDER" PATENT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The interesting action about to be entered into by the Edison Swan Company to substantiate their supposed possession of the master patent on the feeder system, should awaken those interested in electricity supply into activity in opposition to the attempt to gain a monopoly that would be even more seriously influencing than that of the Glow lamp. The feeder can be applied with advantage in almost every system of distribution, whether by low or high pressure, alternate or continuous currents, double or triple wiring; and a monopoly to a form of the controlling patent on such an invention would be of incalculable value, and worth great labour to obtain. Equally disadvantageous would such a monopoly be to the trade; and this should inspire every effort to be exerted to prevent it.

The validity of the patent is one of the main points that the electrical interest can attack; and by way of a starting point I would draw attention to Werdermann's patent, No. 2,477, June 21st, 1878. Edison, it is true, worked very early in this object; but Werdermann's efforts were in advance by about two years; and although he attacks the subject slightly differently, he arrives at nearly the same result. Werdermann's method is shown in its simplest form in Fig. 1, to which he

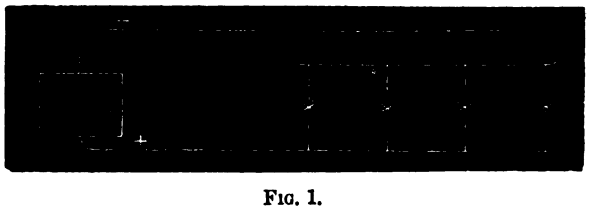


FIG. 1.

refers in these words: "I may so arrange the parallel circuits in which the lights are included that the light which is the first one, or the nearest to the source of the electricity on the positive conductor, is also the first or nearest to the source of electricity on the negative conductor. But I prefer the arrangement illustrated in the drawings in which the lamp or light which is first with regard to its position on the positive conductor, is the last with regard to its connection with the negative conductor. With this arrangement the electric current in all of the lamps or lights will have to flow through the same distance."

Werdermann shows other diagrams which are compounds of the simple one; but they are interesting as showing the method of branching on the same principle. This invention is only made a secondary consideration in Werdermann's patent; in fact, he does not refer to it in the provisional specification, consequently the description is very meagre and the main features are not pointed out, except in the diagrams. Reverting to Fig. 1, is not the lead clearly a feeder to the system of supply mains? And if we show the diagram as in Fig. 2, we have substantially Edison's feeder system with the feeders taken into the supply mains at points wide apart.

Werdermann makes no mention of these feeders directly, but they are conspicuous in his diagrams, and his system could hardly be worked without them.

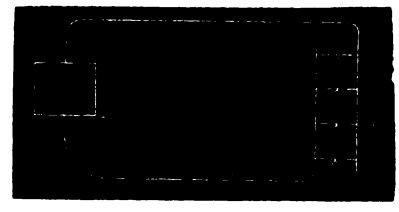


FIG. 2.

It is hard to know where the range of Edison's patent would end. A town with the supply outside would be fed by feeders, and this arrangement might have been specially made for the purpose of equalising the pressure, and could be made with advantage in some cases.—Yours, &c.,

J. D. F. ANDREWS.

Botolph House, 10, Eastcheap, London, E.C.,
March 18, 1890.

COMPOUND CONDUCTORS FOR DYNAMO ARMATURES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of March 14th, under the head of "Paris Notes," I notice "some interesting particulars" of a dynamo made by MM. Reignier and Bary. I beg to enclose a copy of my specification of Patent No. 126, 1889, from which you will see that the use of compound conductors is not new. Owing to a delay in the building of my trial motor I am not yet in a position to give full particulars of the working of these machines. The result, 40 watts per kilo, as a maximum output, does not do these machines full justice. In a large ring armature with small depth of core, such as that used by Messrs. Paterson and Cooper in their "Phœnix" dynamo, a result of at least 80 watts per kilo can be obtained.

In conjunction with Mr. E. Hungerbükler, I have been able to simplify these *electro-magnetic* conductors to such an extent that they can be used on the smallest machines, and even on instruments. The total cost of manufacture will not be much over that of the ordinary covered copper wire now used.—Yours, &c.,

G. B. LÜCKHOFF.

Croydon.

SUBDIVIDED CONDUCTORS FOR ELECTRIC TRACTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As the interpretation of the patent, No. 783, taken out by Prof. Perry and myself in 1881 (as well as of numerous other patents regarding electric traction in which we are interested), must rest with a tribunal having greater authority than can be exercised by the readers of a technical journal who may glance at its correspondence columns, I do not intend to be drawn into a newspaper controversy.

I may, however, mention that when the late Prof. Fleeming Jenkin took out his patent, No. 1,830, in 1882, for a system of subdivided conductors for electric traction, in which the length of each section of the rubbed conductor, and the distance apart of the contact boxes at its ends, were *slightly less* than the length of the moving train, his own patent agent expressed the opinion that such a plan could not be worked without the payment of a royalty to Prof. Perry and myself. Prof. Jenkin

Digitized by Google

then entered into a working arrangement, by which he transferred to us two-thirds of this and of all his subsequent patents connected with electric traction taken out in Great Britain and other countries, and which numbered some fifteen, before his untimely death, in return for one-third of our patents on the same subject transferred to him.—Yours, &c.,

March 18, 1890. W. E. AYRTON.

TESTING GALVANOMETERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: We are sorry to trouble you again on this subject, but trust you will kindly give us space to reply to Prof. Ayrton's letter which appears in your issue of 7th inst.

As to the "taste" in which our former letter was written, we are content to leave the point to the decision of those more competent than Prof. Ayrton to judge of such matters; and will only say that we deferred sending the letter to you until the last possible moment, and after waiting several days for a reply to the letter we had written to Prof. Ayrton.

After we sent our letter to you, we received a letter from Prof. Ayrton, under date February 20th, as follows:—

GENTLEMEN,—I have been so busy that I have not had time previously to reply to your letter of 15th inst.

With reference to the words you quote from *The Electrician* report of the remarks I made on 7th inst. at the Physical Society, I should not, if I had been writing this report, have used the words, "as he believed this was Messrs. Elliott's usual practice," because there is an ambiguity as to whether the word "was" is used in the past tense simply from the report having been put in the third person, in which case "was" might mean that I said, "I believe this is Messrs. Elliott's usual practice." If, however, the reporter meant by the word "was" that such was your practice in former times, then the report would be correct, although ambiguous.

You are under a misapprehension yourselves in your statement to Mr. Mather that, "For the last 25 years at least, it has not been customary to use any other cell than the Daniell's in testing for the figure of merit," seeing that on my going to your testing-room in St. Martin's-lane, in December, 1868—that is, about 21 years ago—to see a galvanometer that had been constructed for me tested, I expressed my surprise to Mr. Becker that he had set up a Grove's cell to be used in testing; and he replied that he always used a Grove's cell for that purpose.

Of this I am absolutely certain, as the incident is very strongly impressed on my mind. It is, therefore, quite certain that 21 years ago the employment of a Grove's cell was your regular practice. I was very careful to explain at the Physical Society that the doubt about what kind of cell was employed only applied to that one instrument, of which both the maker and the tester were, I understood from your letter to Mr. Mather, both dead.

Please bear in mind that the report in *The Electrician* is not the official report of the proceedings of the Physical Society. This, in abstract, you will see in the *Electrical Review* and other papers of the 14th inst., and in greater detail in the copies of the *Proceedings* issued from time to time by the Society itself.—Yours, &c.,

(Signed) W. E. AYRTON.

I take this opportunity of thanking you for all the information you have been so kind as to furnish us with.

To this letter we replied, under date February 21st, as follows:—

SIR,—We are favoured by your letter of yesterday's date, which arrived after we had sent a letter to *The Electrician*, which appears in to-day's issue.

We are under no misapprehension as to our statement to Mr. Mather, and we think you will admit that we are more likely than you to know what our customs are, or have been.

As to the alleged conversation with our late Mr. Becker, we are, of course, unable to speak on the subject, as we presume no third person was present; but if he stated that it was our usual practice to use a Grove's cell in testing galvanometer values, he stated that which was untrue, and this we strongly doubt. The facts and proofs which we have would bear out our opinion that the conversation only exists in imagination.

We cannot follow your argument that, because the incident is strongly impressed upon your mind, it is quite certain that 21 years ago the employment of a Grove's cell was our regular practice.

You say that you were careful to explain that the doubt only related to one instrument, because you understood that both the maker and tester were dead; we cannot see what difference that should make, there is no question as to the cell used in testing for the value of this galvanometer—it was a Daniell.—Yours, &c.,

(Signed) ELLIOTT BROTHERS.

To this letter we would now add the following remarks:—

1. The electrician who coiled and tested all galvanometers from 1865 up to the time of Mr. Becker's death (as our books can show) is still with us, and can state positively that during this period no other cell than a Daniell's was used by him: he can further state that he never remembers Mr. Becker taking a value, and has good reason to doubt that he ever did so.

2. The galvanometer to which reference is made was ordered on December 10, 1868. Prof. Ayrton fixes the date of the test as about December 22, 1868. During this interval only four galvanometers were coiled and tested, each one of which, as shown by our books, was done by the electrician above referred to.

3. Our galvanometer testing-room was on the second floor at our former premises, and if Mr. Becker wanted to see the value of any galvanometer taken he invariably went to this room for the purpose.

For the moment, disregarding the above facts, and assuming that Prof. Ayrton did see a galvanometer tested with a Grove's cell 21 years ago, assuming even that Mr. Becker said he always used a Grove's, we would ask—

1. Was it "unquestionable taste" on the part of Prof. Ayrton, in face of the positive denial given in our letter to Mr. Mather, to make the statement at the Physical Society to which he admits?

2. What ground had he for throwing a doubt upon the method of testing a galvanometer which we had told him was made and tested several years afterwards?

3. Why should he throw the doubt upon one particular galvanometer, the maker and tester of which he understood were both dead?

We leave your readers to draw their own conclusions, as we have done.—Yours, &c. ELLIOTT BROTHERS.

101 and 102, St. Martin's-lane, London, March 12, 1890.

ENGINEERS', ELECTRICIANS', BUILDERS', AND IRONMONGERS' EXHIBITION.

This Exhibition, which will remain open for a fortnight, was opened on Monday last at the Agricultural Hall, London, N., and was then in the usual backward state. Later in the week, however, many of the exhibits were in their places, and there is every reason to suppose that, taken altogether, the Exhibition will be a success. A number of well-known engineering firms are represented, some of them with very excellent exhibits; this is particularly the case with fittings for gas and electric light, gas engines, &c.

The exhibits of Messrs. O. Berend and Co., of Fore-street, E.C., at Stand 8, were not complete at the time of our visit; but we may mention that their capital show includes a number of Hartmann and Braun's volt- and am-meters, Cathcart and Peto's portable electric lamps, Poole and White's switches and cut-outs, &c., &c.

At Stand 23, Mr. A. G. Hamilton, of York-road, Lambeth, S.E., has on view a number of very artistic electric light fittings in wrought-iron work, a branch of electrical industry to which he pays special attention.

At Stand 44, Messrs. Dan Rylands (Limited), of Barnsley, exhibit a number of samples of their glass-lined metal piping, which they claim is especially suitable for electric light mains. We believe that Messrs. Rylands anticipate a very large business in this direction. The piping consists internally of a distinct solid glass tube, which is covered and protected externally by ordinary iron tubing, a suitable cement being inserted between each, which makes the whole homogeneous and renders the pipe unbreakable with ordinary use. Messrs. Rylands claim that the pipes can be easily laid, and are cheap. No solder is required, as each pipe carries a union end by means of which the lengths are screwed up without difficulty, a thin washer of gutta-percha or other suitable packing being interposed to secure a perfectly solid joint. It is further claimed that these pipes will successfully resist the action of frost or extreme alternations of heat and cold. For electric light purposes the solid glass tube forms a good insulating medium, while the outside iron piping is a protection both to the wires and the inside glass tube.

At Stand 47, Messrs. Ramsay and Hickman, of St. John's square, E.C., have a good display of engineers' tools and surface plates, lathes, &c.; at Stand 56, Messrs. Smith and Claydon, High street, Borough, S.E., show their "Economic" durable enamel paint, which they claim is especially suitable for machinery; and

Digitized by Google

at Stand 58, Mr. Samuel Buckley, of Guide Bridge, near Manchester, has a good exhibit of engineers' tools, including tube wrenches, tube cutters, screw stocks and guides, tube vices, pipe-drilling apparatus, &c.

In the centre of the Hall, at Stand 73, Messrs. Aspinall, Aspinall, and Co. have an elegant display, showing the application of their well-known enamels to all descriptions of work. This is undoubtedly one of the neatest shows in the Exhibition.

At Stand 112 will be found a ½-horse power Fawcett gas engine. It is manufactured by Messrs. Fawcett, Preston and Co., of Liverpool. A number of advantages are claimed for the engine over others in the market, particulars of which have been promised us. We understand that an 8 horse-power engine of this type is used in the installation of the electric light at the Liverpool University. These engines are built up to 20 horse-power nominal.

Messrs. Winnall, Callow, and Winnall, of Stepney, show at Stands 123 and 172 some electrical appliances, including a new electric bell. One of their principal exhibits, however, is the Chiswick Floor-Lifter, which the Company inform us is in use by a number of electrical firms. It is designed for the purpose of obviating the difficulties experienced by persons putting machinery into floor-boarded buildings. This patent floor-lifter is an upright steel screw, for which it is necessary to make a 1-inch centre-bit hole. When that is done the floor-lifter is inserted, and by the use of an ordinary tommy the floor lengths are lifted bodily, without injury to the boards or to the ceiling underneath. This firm also exhibit a Newall engine which is to drive a Phœnix dynamo, but this was not in action at the time of our visit.

The Campbell gas engine is on view at Stand 144; and a handsome display of fittings is shown at Stand 148 by the Thomas Lighting Company.

One of the best exhibits is that of Messrs. Crossley Bros. (Limited), who have on view a 14 horse-power Otto gas engine, fitted with all the most recent improvements, and capable of indicating up to 33 horse-power. This engine is driving a 30-arc-light Thomson-Houston dynamo for the installation of the electric light put down by Messrs. Laing, Wharton, and Down, which is the largest, as it is undoubtedly the best, installation in the building. In addition to this engine, Messrs. Crossley exhibit a 4 horse-power and a 2 horse-power engine of their horizontal type, and a 1½ horse-power vertical engine and hoist.

At Stand 156, Messrs. J. E. H. Andrew and Co. show several examples of the Stockport gas engine, including one of 8 horse-power, which drives a Phœnix dynamo supplying seven Phœnix arc lamps. At the time of our visit, this, with Messrs. Laing, Wharton, and Down's exhibit, was the only installation of any magnitude in the building.

The Weymersch Electric Battery Syndicate have a neat show at Stand 169. A number of batteries of the Weymersch type are on view, together with a good display of electric light fittings made by the Planet Electrical Engineering Company (Limited). There is also exhibited a small Crocker-Wheeler 10-volt motor, used for working a model ventilator.

At Stand 173, the Blackman Air Propellor Company, of Fore-street, E.C., have an effective exhibit, the ventilators being driven by one of Mr. E. S. Hindley's vertical engines from the adjoining Stand (174), where Messrs. Hindley have on view a number of engines of their well-known types.

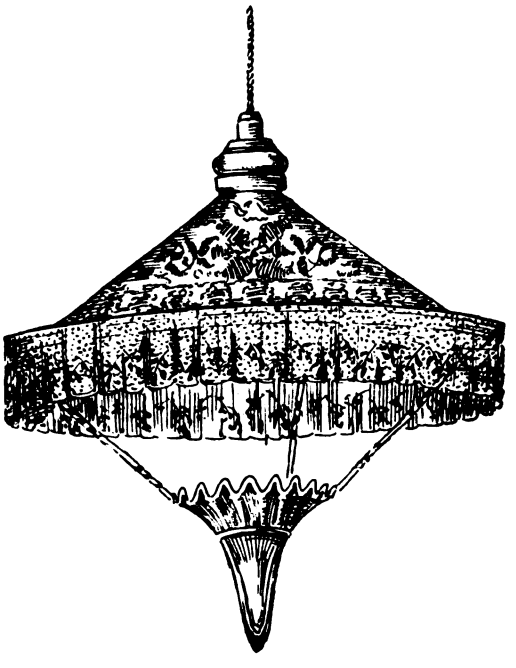
At Stand 175, Messrs. Dick, Kerr, and Co. show the Griffin gas engine, one of which is driving a Phœnix dynamo feeding a Kent arc lamp. There are also on the stand an Excelsior dynamo made by Messrs. Oppermann, and a number of instruments, switches, &c., manufactured by the Acme Electric Works. This firm hope shortly to have a large gas engine down to drive a Tyne dynamo (manufactured by Messrs. Ernest Scott and Co., of Newcastle), which is already in the building awaiting the arrival of the engine.

The largest exhibit is undoubtedly that of Messrs. Allday and Onions, who have a very effective display of engineers' tools, portable forges, stocks, taps, dies, hammers, &c.

From the above remarks it will be seen that, although the Exhibition is not a large one, there is a fair sprinkling of well-known electrical and engineering firms represented. As many of the exhibits were in anything but a forward state, we must reserve our remarks thereon until next week.

THE E. P. COMBINATION FITTING.

Manufacturers of electrical fittings are now continually introducing novel designs, and the annexed cut illustrates what is certainly a new combination for pendants, though the same idea has been for some time employed in the case of brackets. The fitting shown has been brought out by the proprietors of the "Electrical Plant" Stores, the special name of "E. P. Combination Fitting" being given to it. An ordinary opal or flint glass conical shade (etched or decorated in a variety of designs) is provided with a slightly turned-up rim, from which are hung three brass arms fixed to a brass ring underneath to carry a small glass flower or bouquet-holder. The brass arms are also provided at the top each with another hook pointing outwards (not shown in the sketch); on these hooks is placed a plain wire ring threaded through lace or silk fringe. This fitting—which is also constructed in wrought-iron, copper, or any other material lending itself to artistic treatment—presents a neat appearance, and can be turned out at a moderate



cost. It should prove serviceable for suspending over dining tables, or for use in drawing rooms and boudoirs. The makers have registered the various designs and patented the combination as applied to a pendant.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning.*]

Sale by Auction.—The sale by auction of the modern engineering machines, tools, plant, and stores will take place at 417, Old Ford-road, Bow, London, E., on Tuesday next, at 12 noon prompt. Further particulars will be found in our advertisement columns, and catalogues can be obtained on application to Messrs. Wheatley Kirk, Price, and Goulty, 52, Queen Victoria-street, London, E.C.

Messrs. Johnson and Phillips.—We have received from this firm Catalogue and Price List No. 3, containing illustrated descriptions of the well-known Brockie-Pell arc lamp. Opinions of the press regarding the lamp are also given, as well as excellent testimonials from a number of prominent members of the electrical profession, including Prof. George Forbes, Prof. S. P. Thompson, Mr. W. H. Preece, and Mr. W. Lant Carpenter. A list of the principal users of the lamp is added, amongst them being several of the British Government Departments; the Governments of New South Wales, South Australia, Germany, Russia, Italy, and Japan; the Corporations of Leeds and Blackpool; large towns in the Colonies, &c.; societies and colleges; several of the British railway companies; dock and harbour boards; steamship, telegraph and mining companies; electric supply companies' lighting stations, including the Metropolitan, London, Liverpool Manchester, House-to-House, Chelsea, Brighton and Hove, Chatham, Rochester and District, Eastbourne, Keswick, Berlin Elektricitäts-Gesellschaft, Hong Kong, Shanghai, and the River Plate Companies. A lengthy array of electrical and miscellaneous companies and firms, and theatres using the Brockie-Pell lamp, concludes what is undoubtedly a very influential list. The catalogue also contains illustrated descriptions of special fittings made by the firm; and some useful tables are given, comparing the electric light with gas, oil, and candles, both as regards brilliancy and as affecting health.

Messrs. Paterson and Cooper.—We are in receipt of the newly-issued catalogue of dynamos and electric lighting apparatus of this firm, containing a revised price list of the various sizes of

Digitized by Google

the Phœnix dynamos for arc lighting, copper refining and electro-deposition, electro-plating, steamship lighting, &c. Particulars are also given of combined and inverted engines and compound-wound Phœnix dynamos, as well as of combined single-acting closed engines and compound-wound Phœnix dynamos, accompanied in each case by figures. An illustration is also given of the Gwynne-Cooper dynamo, which is a directly-coupled engine and dynamo, for which it is claimed that, owing to the small space taken up, the arrangement is specially suitable for ship lighting, or where space is limited and valuable. The catalogue likewise contains illustrated descriptions and revised prices of the Phœnix differential arc lamps and of the Phœnix carbons. A number of useful tables are also given, and the catalogue concludes with some flattering testimonials from firms who have used for some time the dynamos and electrical apparatus made by Messrs. Paterson and Cooper. We may mention here that a small installation put down by Messrs. Paterson and Cooper can be seen at work at the Exhibition now being held at the Agricultural Hall, Islington, N.

BERNSTEIN ELEKTRICITÄTSWERKE.—Mr. Alexander Bernstein informs us that he has sold his business and works at Hamburg to a private company, who will trade under the above title. The change has been necessitated by the increased demand for the specialities made by the firm.

THE UNIVERSAL TELEPHONE COMPANY.—We are informed that Messrs. Daniel Judson and Son (Limited) have disposed of their telephone business to Messrs. P. P. Kipping and Co., trading as the Universal Telephone Company. The new company have taken the offices recently vacated by Messrs. Woodhouse and Rawson, at 11, Queen Victoria-street, E.C., and announce that they are prepared to estimate for all kinds of telephone work.

COMPANIES' MEETINGS & REPORTS.

The New Australian Electric Company.

The first half-yearly meeting of shareholders in this Company was held on January 31st at the City Bank Hall, Melbourne, Victoria.

Prof. Kerenot occupied the chair, and submitted the report of the Directors, which contained the following information:—

As the result of the transactions for the last six months, there remains a net profit of £1,942. 9s. 9d., out of which it is proposed to pay a dividend at the rate of 10 per cent. per annum, leaving a balance of £1,068 8s. 3d. to be carried forward. In accordance with the objects for which the Company was formed, your Directors purchased the business of the Australian Electric Company (Limited), as a going concern, for 8,382 fully-paid shares in this Company, and undertaking to discharge all its obligations, taking it over as and from July 1, 1889. The plant so acquired was of the highest value, being of modern type and in first-rate order, and in the hands of the new Company is being fully utilised with highly profitable results, enabling a dividend to be declared for the first six months. In view of the rapid advancement of electric lighting, and in order to meet the demands of the numerous applicants for the light in Melbourne and suburbs, and to fulfil lucrative contracts, the Directors determined to largely increase their lighting power, and therefore purchased on favourable terms a piece of land upon which they could erect a new lighting station and factory, comprising about two acres, situated at Richmond, close to the South Yarra railway bridge, adjoining the railway, and having a river frontage, thus providing an abundant and inexpensive water supply for the machinery. It is likewise the centre of a most important lighting area. They were further able to purchase upon exceptional terms a most complete and modern arc and incandescent plant with engines and boilers, just landing in Melbourne. Both buildings and plant are being arranged so that additions can be made from time to time to keep abreast of all demands until the whole of the ground is covered. The Directors have effected important changes in the management. Captain Rowan, formerly Managing Director, resigned his position, and also retired from the Board. The offices of the Company were removed to the lighting station at Russell-place, and other changes have been made, effecting a saving of over £1,000 per annum in working expenses. As the Board is of opinion that a Managing Director is unnecessary, you will be asked to amend the Articles of Association, and abolish that office, as at present it is mandatory that there should be one. The Directors feel assured that the New Australian Electric Company (Limited) having been started under such favourable auspices, and having secured a most valuable property at a great bargain, has a successful future before it, and presents a highly promising field for investment. Fresh capital is needed for the erection and completion of new plant and the extension of business in portions of the city and suburbs not yet provided with electric light. The first issue of 30,000 shares not being yet fully subscribed for, the balance, amounting to 13,031, is now offered to shareholders—terms: 5s. on application, and 5s. on allotment—and immediate application is necessary, as they will be allotted in order of application.

The CHAIRMAN, in moving the adoption of the report and balance-sheet, said that electric lighting had been rather a drag on those who had invested in it, but the time had come for a change. This was a new Company, formed on a different basis from the old one, and free from many of its disadvantages. As to the dangers of electric lighting, he pointed out that there was danger in connection with gas or anything else until people became acquainted with its use. Even at present accidents from gas were of frequent occurrence. In America there had been deaths caused by electric currents, but these were due to carelessness in fitting up and working. High-tension currents had been in use in Europe for years past, but it was only in America that deaths had taken place. In London a high-tension current far stronger than that which would be adopted here had been in use for four years over several miles, and not a single accident had been reported. These currents were also in use in Rome, Milan, and Vienna and elsewhere, without causing deaths or injuries. This Company was not going to run any risk, and would use only the best materials, and employ the best men and take every reasonable precaution in fitting up. Their experience was that they could use high tensions with perfect safety. They had in their possession about 60 miles of special wire of a costly description, made expressly for the purpose of conveying currents with safety. The scare about danger from electric lighting was plainly due to work being badly and cheaply done, and without proper precautions. With the proper precautions electricity was as safe as anything else. The Richmond Council had adopted the electric light for the street lamps, and this company would supply it, the cost being rather less than that of gas.

Captain ROWAN seconded the motion. He stated that his retirement from the position of Managing Director did not indicate that he was out of sympathy with the policy of the Board. There were certainly differences of opinion, but their policy was being carried out on a sound basis and the outlook was decidedly good. He mentioned that the Brush Company had thought it worth while to repurchase the whole of their Australasian patents, and intended to push them, having every confidence in the future of electric lighting in these colonies.

The report was adopted, and a motion to declare a dividend of 10 per cent. was agreed to.

Prof. Kernot, Mr. J. F. Levien, and Mr. B. J. Fink, the retiring Directors, were re-elected. Mr. F. A. Wilson was re-elected auditor.

The Articles of Association having been altered to the extent of abolishing the office of Managing Director and removing all consequential references to that office, the meeting closed.

PATENT
SILICIUM BRONZE AND SILICIUM COPPER WIRE.
The best for overhead Telephone and Telegraph Lines,
AND ALL ELECTRICAL PURPOSES.
Hard Drawn High Conductivity Copper Wire.
ROLLED AND DRAWN
PHOSPHOR BRONZE.
PHOSPHOR BRONZE
BEARINGS, BUSHES,
AND OTHER PARTS OF
ELECTRICAL MACHINERY.
SOLE PROPRIETORS of the British, Indian and Colonial Patents,
THE PHOSPHOR BRONZE COMPANY (Limited),
87, Sumner Street, Southwark, London, S.E.
WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

Digitized by Google

The Newcastle Electric Supply Company (Limited).

This Company held its first annual meeting at its offices, 1, St. Nicholas-buildings, Newcastle-on-Tyne, on Monday afternoon last.

The Directors reported that since they met the shareholders in May last the Company have erected a building in Pandon Dene, in which they have placed two boilers and two engines of 200 horse-power and two dynamos. The Company was prevented by unforeseen difficulties with regard to the Board of Trade licence from commencing to lay their cable until December 11th last. Since that date they have laid 5,400 yards of pipes, with 125 junction boxes, and drawn in 1,600 yards of cable, besides 300 yards of temporary cable on ground not yet ready for permanent work. The work of actual lighting was commenced on January 31st last, and at the present time the Company is daily supplying current for 800 ten-candle lamps. Contracts have been entered into equivalent to about 2,500 ten-candle addititional lamps, which will be brought into work as fast as the necessary wiring of the premises can be completed. Negotiations are pending with many persons who contemplate using the electric light. The Directors report that they have agreed with the Newcastle and District Electric Lighting Company (Limited) for a division of the electric lighting work to be done in this city. Roughly speaking, this Company takes the eastern half, and the other company the western half. The capital of the Company, £15,000, which comprises the first issue, has been fully subscribed for, of which £12,000 has been called up (including £1 per share payable on the 24th inst.), and it is not intended to make any further call on these shares. But the Directors being of opinion that the demand will overtake their present power of supply before next winter, have determined to extend the buildings and to lay down a third set of plant. They further think that some provision of working capital should be made for indoor wiring work which it is desirable the Company should be prepared to undertake when required, and altogether they consider that the expenditure of a further sum of £7,000 is desirable. The Directors have made arrangements for the provision of this money. The Directors recommend that the number of Directors, which is at present seven, be increased to nine.

The report and accounts were adopted and approved, and it was resolved to increase the number of Directors to nine.

The whole of the retiring Directors were re-elected, and Colonel Sheppee, of the Birtley Iron Company, and Mr. James Knott, shipowner, were elected additional Directors.

The Telephone Company of Egypt (Limited).

The following is the report of the Directors for the year ended 31st December, 1889, to be presented at the seventh ordinary general meeting of the Company, to be held at the registered offices of the Company, 14, Austinfriars, E.C., on Tuesday, the 25th inst., at 12:30 p.m.

After writing off a sum of £250. 2s. 11d. for depreciation, and providing for the interest on debentures, the net profit for the year is £4,011. 0s. 5d. Adding to this amount the sum of £1,069. 6s. 11d. brought forward from 1888, the balance available for disposal is £5,080. 7s. 4d. Out of this the Directors recommend a dividend of 6 per cent. for the year on the Preferred shares, free of income-tax, which will absorb £3,621. 6s., leaving £1,459. 1s. 4d. to be carried forward.

The amount brought into the credit of revenue account in respect of subscriptions and rentals shows but a small increase over the previous year. This is due partly to a falling off in the number of subscribers connected during the year, and to the elimination of some overdue subscriptions, the realisation of which the Manager reports as doubtful.

A further growth of the exchanges at Alexandria and Cairo does not appear probable for the present, and the Directors are therefore endeavouring to extend the use of the telephone to other towns in Egypt.

They are glad to be able to announce that an exchange was opened at Port Said on January 28th, and, according to the latest advices received, twenty subscribers had been connected. The manager anticipates that before the close of the current year this number will be materially increased. The Directors hope also to be able to establish a small branch at Assiout during the next few months.

Under the Articles of Association, Mr. Thomas Lloyd retires from the direction, but being eligible offers himself for re-election. Messrs. Price, Waterhouse, and Co., the auditors of the Company, also retire, and offer themselves for re-election.

NEW COMPANIES REGISTERED.

ELECTRICAL ENGINEERING COMPANY OF IRELAND (LIMITED).—This Company has been formed with a capital of £50,000, divided into 24,950 ordinary shares of £2 each, and 100 founders' shares of £1 each, with power for the Directors to borrow to the amount of £15,000. The electrical engineer to the Company is Arthur E. Porte, A.I.E.E., and the secretary (*pro tem.*), J. Buckley. The consulting engineers are John S. Raworth, M.I.E.E.; R. Percy Sellon, M.Inst.E.E.; W. G. Strype, C.E., M.I.C.E., M.I.M.E. The temporary offices of the Company are at 46, Dame-street, Dublin.

FOREIGN AND COLONIAL ELECTRICAL POWER STORAGE COMPANY (LIMITED).—This Company has been formed with a capital of £100,500, in £5 shares, to acquire certain foreign and colonial patent rights for inventions relating to the storage and supply of electricity by batteries or accumulators upon the principle known as the "E. P. S." system. It is proposed to purchase these rights from the Electric Construction Corporation (Limited), of Worcester House, Walbrook, E.C., and Wolverhampton, who now hold them, and who are the promoters of the Company, for the sum of £75,000, payable in cash or shares at the option of the Company. One hundred of the shares are founders', which will receive no dividend in any year until the ordinary shares have received 8 per cent. for that year.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The receipts of this Company for the week ended March 14th amounted to £4,644.

GULCHER (NEW) ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—We have received a note from Mr. G. Binswanger announcing that he has resigned his seat on the Board of this Company. In his note he reminds the shareholders of the Company that he was elected to represent the interests of the creditors of the old Company who exchanged their claims for shares in the new Company. As the issue of the remaining shares has been successfully accomplished, Mr. Binswanger considers his task at an end. In regard to the reference made by Mr. Binswanger to the subscription of the capital, last week the Company effected a new issue of 37,723 Ten per Cent. Preference shares of £1 each, making the capital of the Company £70,000, in 70,000 shares of £1 each, of which 50,000 are Preference shares and 20,000 Deferred shares. These latter are not entitled to any dividend until 10 per cent. has been paid to the Preference shareholders, and any surplus is to be ratably divided between the Preference and the Deferred shareholders. The Preference shares are also entitled to priority in respect of capital in the event of any sale or liquidation of the Company's assets. Out of the total of 70,000 shares 37,000 have been applied for by the Directors and their friends. It is proposed, out of the present issue, to pay off £16,000 of Ten per Cent. Debentures. This will give the Company an additional working capital of £21,500, of which it is intended to leave about £13,000 uncalled, to meet future contingencies. The Company confidently anticipate being able, after allowing for depreciation and other expenses, to pay 10 per cent. on the Preference capital. The prospectus of the new issue notifies that the Gülcher Company is one of the few electric light companies of the many formed in 1882 which have survived to the present day. It has a sound and increasing business, first-class plant and machinery, and an experienced and skilled staff of officers and workmen, and the dynamos and other manufactures of the Company are among the few that have been accepted by the British Admiralty Department.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY, LIMITED.—The traffic receipts of this Company for the week ended March 14th, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,485.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The receipts of this Company for the half-month ended March 15th were £3,502, showing a decrease of £126 as compared with the corresponding period.

THE NON-CONDUCTOR OF ELECTRICITY.

VULCANISED FIBRE,

PATENTED.

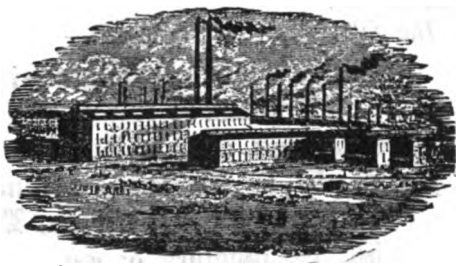
This new material is supplied in two qualities, Flexible and Hard.

The FLEXIBLE is a substitute for Leather, Rubber, Gutta Percha, &c., and is extensively used by Brass Founders, Axle Makers, Hydraulic, Sanitary, and other Engineers, Pump Makers, Carriage Builders, &c.

It makes the best Hot and Cold Water Packings, and for Axle Washers of all kinds it is unequalled.

The HARD is a substitute for Metals, Hard Wood, Ivory, Vulcanite, Ebonite, &c., and is a good Insulator.

Sold in sheets, 5ft. 6in. by 3ft. 6in., varying in thickness from 1-50in. to 1in.



FLEXIBLE, 2/- per lb. | HARD, 2/3 per lb.

MOSSES & MITCHELL, 70 Chiswell-st., London, E.C.

Digitized by Google

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Wednesday, March 19, 1890	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending March 19, 1890.	
£			**TELEGRAPHS.**		£ s. d.		Highest.	Lowest.
1,770,360	Stock	15/0	Anglo-American	49 50	5 10 0	Jan., Apr., July, Oct.	49⅞	...
2,614,820	Stock	30/0	Do. Preferred	82½ 83½	6 11 9	" "	84	83½
2,614,820	Stock	...	Do. Deferred	14¼ 14¾	...	February	14⅞	14⅝
130,000	£10	3/0	Brazilian Submarine	12½ 13	5 15 5	Mar., June, Oct., Dec.	12⅝	12⅜
112,900	£100	5%	Do. 5 per Cent. Bonds	100 102	4 18 0	January and July	...	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	104 107	4 13 6	June and December.	...	...
16,000	10	9/0	Cuba Submarine	11 11½	7 16 6	February and August	11⅝	11½
6,000	10	10%	Do. Preference 10%	17½ 18½	5 8 1	" "	...	...
12,931	5	2/0	Direct Spanish (£4 paid)	4 4½	4 8 11	March & September	...	...
6,000	5	10%	Do. Preference 10%	9 10	5 0 0	April and October	...	...
60,710	20	3/6	Direct United States	10⅜ 10⅝	6 15 0	Jan., Apr., July, Oct.	10 7/8	10½
380,000	10	2/6	Eastern	14 14¼	4 11 3	" "	14¼	14
70,000	10	6%	Do. 6 per Cent. Preference	14¾ 15¼	3 18 8	" "	15 1/8	14¾
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock	106 108	3 14 1	May and November.	107¼	106¼
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	106 109	4 11 9	February & August	108	107
250,000	10	2/6	Eastern Extension	14 14¼	4 11 3	Jan., Apr., July, Oct.	14⅛	14
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	100 102	5 17 8	February & August	100½	...
473,000	100	5%	Do. 5 per Ct. (Austrln. Gov. Sub.) Debs. 1900	102 105	4 15 3	January and July	...	...
179,177	10	1/9	Globe Telegraph and Trust	8½ 8¾	6 2 10	Jan., Apr., July, Oct.	8⅝	8½
178,992	10	6%	Do. 6 per Cent. Preference	14½ 14¾	4 1 4	" "	14⅝	14½
150,000	10	5/0	Great Northern	15½ 16	4 13 9	Jan., July, and April	15⅝	...
17,000	25	12/6	Indo-European	41 43	5 16 3	April and October	42½	...
9,000	8	4/0	Reuter's	7 7½	5 6 5	April and October	...	...
15,609	10	3/6	West African Telegraph	9½ 10½	...	...	...	...
300,000	100	5%	Do. 5 per Cent. Debentures	98 101	4 19 0	March & September	100	99
80,000	10	5/0	West Coast of America	10¼ 10⅝	4 13 0	January and July	10⅝	10
150,000	100	8%	Do. Debentures 8%	121 126	6 7 0	June and December	...	...
88,321	10	nil.	West India and Panama	3⅛ 3½	...	...	3⅜	...
34,563	10	12/0	Do. 1st Preference 6%	11½ 12	...	April and October	12⅛	11 1/8
4,669	10	10/0	Do. 6 per Cent. 2nd Preference	15 16	...	...	...	...
45,181	15	6/0	Western Brazilian	10¼ 10⅜	6 19 8	May & November	10⅜	10¼
$1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	118 122	5 14 9	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	99 101	5 18 10	March & September	...	...
			TELEPHONES.					
224,850	14/0	5%	Consolidated Telephone and Maintenance	1 1/16 1 1/8	5 12 0	Yearly	...	...
220,000	£1	3%	Oriental (11s. paid)	7/8 1	3 5 11	...	...	...
80,000	5	3/0	National	5⅛ 5⅜	...	June and December.	5⅜	5⅛
55,000	5	2/0	United River Plate	4⅝ 5⅛	...	January and July	4⅞	...
			ELECTRIC LIGHT.					
500,000	10	...	Metropolitan Electric Supply (£6 paid)	5⅜ 6⅛	...	...	6	...
79,934	5	6%	Swan United (£3. 10s. paid)	4⅜ 5⅛	4 0 0	...	5⅛	4⅞
			MISCELLANEOUS.					
37,350	12	12/0	Telegraph Construction and Maintenance	42 44	5 9 3	March and July	43⅞	42⅝
41,600	10	10/0	India Rubber, Gutta Percha & Telegraph Works	17½ 18½	5 8 1	February & August	18⅝	18

JABLOCHKOFF'S
DISTRIDUTION PATENT

(Being a Patent for "Producing and Dividing Electric Light," No. 1996 of 1877.)

THE
ELECTRICAL ENGINEERING CORPORATION, Ltd.

(STATTER'S) Are Proprietors of the above Patent, and Warn the Public against Infringement. (UNITED).

The following are Licensees:—

Brush Electrical Engineering Company, Limited.
Crompton & Co., Limited.
S. Z. de Ferranti,—London Electric Supply Corporation, Limited.
W. T. Goolden & Co.
Hammond & Co.
Wilson Hartnell.
Johnson & Phillips.
Laurence, Paris & Scott, Limited.
Nalder Brothers & Co.
Paterson & Cooper.
Ernest Scott & Co.
Siemens Brothers & Co., Limited.

3, Prince's Mansions, Victoria Street, Westminster. PERCY E. SCRUTTON, *Secretary.*

Digitized by Google

THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 619.—Vol. XXIV. FRIDAY, MARCH 28, 1890. Price Fourpence.

NOTES.

The long and animated discussion at the Institution of Electrical Engineers, which followed the reading of the Papers of Messrs. Swinburne and Esson, will compare in interest and general importance with that which arose in connection with the subject of transformers two years ago. Although the Papers and the subsequent discussion were devoted more especially to the details of dynamo construction, yet, as was pointed out by Prof. Forbes, electrical engineering has now reached a stage at which the study of these minor points is all that remains to be done.

The Papers and discussion were remarkable for the numerous empirical rules suggested for practical use as the result of experience. There does not appear to be any satisfactory means of calculating the performance of large machines from observation of small machines of a similar type. On the other hand, several speakers bore witness to the possibility of calculating the magnetic leakage, occurring in dynamos, with sufficient accuracy for practical purposes. In connection with this subject, a very simple method of plotting the lines of force in the neighbourhood of dynamo machines was described by Mr. A. P. Trotter.

Some discussion took place on the advantages and disadvantages of the term "magnetic resistance." The President objected to it, firstly, because it did not represent waste energy, and, secondly, because it was not constant. The first objection was pointed out some time since by Mr. Oliver Heaviside, who, in consequence, proposed to substitute the phrase "*magnetic reluctance*." The second objection might, as has been pointed out in our correspondence columns, be made with equal force against the custom of talking of the "resistance of an incandescent lamp." The use of some such phrase as "magnetic reluctance" is the natural outcome of Mr. Kapp's celebrated Paper on the magnetic circuit, which is acknowledged to have much simplified dynamo design. Whether the term adopted is "resistance" or "reluctance," or any other, is a minor matter.

The supremely important question whether motors and dynamos should differ radically in design, although carefully avoided by some notable speakers, gave rise to several most emphatic expressions of opinion. Indeed, so emphatic were these expressions of opinion that they have called forth a protest from Prof. Perry, who, in a letter which we print in another column, takes exception to the epithet "nonsense" as applied to his and Prof. Ayrton's theory of motor design. The language used by some of those who took part in this debate certainly could not be accused of want of vigour; and although the discussion consequently gained in piquancy, its practical value was not greatly enhanced. So far from crying "peccavi" on the question of motor design, Prof. Perry, it will be seen, is astonished at the soundness of the views held by himself and Prof. Ayrton on this subject so far back as 1883.

The experiments of Prof. Ayrton on Immisch and other motors certainly tend to show that the strength of the field in which the armature revolves is increased by the armature reactions; and these views were confirmed by Mr. A. T. Snell, who pointed out several differences between motors and dynamos, and stated that it was possible to get a greater output from a given machine when run as a motor than as a dynamo. The balance of opinion was, however, decidedly in favour of the view that, although the armature reactions in the motor may in some cases increase the field strength, the best results in practice were to be obtained by arranging, as in a dynamo, so that the armature field opposed the induction due to the field magnets.

At the Royal Society on Thursday last Prof. Schuster read the Bakerian lecture on "Conduction in Gases." The Paper, which was one of great originality and power, put forth some new theories, supported by many novel facts, some of which had been previously brought to the notice of the Society by the author. Four different causes for electric conduction in gases were distinguished, arising from the heating of the electrodes, the action of ultra-violet light, the action of flames, and the phenomena of electric discharge, as in vacuum tubes. A new theory was advanced to explain the origin of the dark space in vacuum tubes, and the distribution of the electrified particles was discussed. Another matter brought forward was the fall of potential within the tube. The form of the potential curve obtained was found to be the same for every density, and the conclusions arrived at were that the negative pole was surrounded with positively-charged particles; and that, in order to account for the passage of electricity, it was necessary to assume that about one molecule in every million is decomposed into its constituent atoms. A proof was also given that the quantity of electricity carried by the atoms in the discharge is of the same order as those carried in electrolysis.

Digitized by Google

Those who were fortunate enough to gain admission last Friday to the Royal Institution to hear Prof. Fitzgerald lecture on "Electro-magnetic Radiation," a report of which will be found in another column, witnessed an exhibition of experiments which have hitherto only been performed in comparatively few laboratories. All Hertz's chief experiments were repeated, and the electric oscillations were made visible to the large audience by means of the simple galvanometer method of detection, discovered by Prof. Fitzgerald, and described in our editorial columns two or three weeks back. Reflection by plane and parabolic surfaces, polarisation, and interference, were all experimentally demonstrated in connection with electric undulations. The shape and movement of the electric waves were vividly shown by means of lantern projections on the screen. In order to make the figures blend successively into one another and present a continuous progressive appearance, an ingenious modification of the zoetrope was employed, designed by the learned Professor, who humorously gave it a name far too long to print. One very interesting and important result of the electro-magnetic theory is that the electric energy radiated from an origin of alternating currents is for the most part returned. Only the portion which gets beyond a range of a quarter of a wave-length, and which in all practical cases is insignificant, is really lost. Thus, with an alternating-current dynamo running at a speed corresponding with 100 periods per second, the wave-length is about 2,000 miles, and the amount of energy lost by radiation corresponds only with the electric forces exerted by the dynamo at one-quarter of this distance, viz., 500 miles, and is thus quite negligible. The bulk of the radiated energy travels backwards and forwards over the immense distance of 500 miles 400 times in every second. It would have been interesting to learn what proportion this radiated energy bears to the output of the dynamo; but this, of course, was not within the scope of the lecture, which, indeed, left out of account altogether the transmission of energy by conduction.

In an interesting article in the current number of the *Nineteenth Century*, Prince Kropotkin gives us his views on the subject of "Brain Work and Manual Work." Technical education, in the ordinary acceptation of the phrase, he will have none of. The reproach of waste of time which is brought against workshop apprenticeship is, he thinks, equally applicable to those technical schools which endeavour at once to teach some special handicraft. For specialism in manual and scientific training, Prince Kropotkin would substitute systematic instruction in the fundamental methods which underlie all handicrafts, and in the fundamental ideas which underlie all sciences. With this groundwork of theory and practice he anticipates that the worker will soon specialise for himself, and will succeed all the better for not having been from the commencement kept in a comparatively narrow groove. The article is evidently written throughout under the impression that the sole object we have in view in this country in founding technical schools is the highly laudable one of turning out men capable of competing with the foreigner. That this is the origin of the support given by the public to technical education we have but little doubt; but many of its most ardent advocates are animated quite as much with the desire of raising the manual worker to a higher level, as with what the author of the article loftily terms "the shopkeeper's view" of the question."

The choice of Chicago as the site of the next World's Fair has of course given rise to considerable jubilation in "the most liberal, practical, and active city in the world." Although we are unable to endorse all the superlatives so lavishly employed in this connection, or even to go so far as our esteemed contemporary the *Western Electrician*, and assert that "the World's Fair of 1892 or 1893 will doubtless be the most important international exposition ever held, and the Electrical Exhibition will be its crowning feature," we shall indeed be surprised if Chicago, with the manifold advantages it possesses, fails to make its Exhibition at least compare favourably with that held last year at Paris.

We are glad to be able to inform our readers that the problem of successfully applying electricity as a motive power to vehicles has at last been solved. As our readers are aware this problem has occupied the minds of inventors for some time past. Electricians have generally declared the use of a primary battery impossible for this purpose; but it is needless to say that electricians are all wrong; a primary battery *has* been discovered, and the "principle" has been applied—so at least we gather from the *Citizen*—to bath chairs, pleasure boats, and tricycles, and, within a limited period, tramcars, carriages, and trains will fall victims to the new power. An invention of this magnitude has, of course, an immense future; and when primary batteries are employed to drive tramcars at least one revolution may be predicted.

We have learnt from Sir William Thomson that the current in Lord Armstrong's experiment was direct, and not alternating, as inadvertently stated in our notice of last week. We shall be able next week to present our readers with an abstract of Sir William Thomson's Paper before the Royal Society of Edinburgh, wherein the theory of this experiment is discussed.

Richmond (Victoria).—The municipality of Richmond, an important suburb of Melbourne, have decided that their streets shall be lighted by electricity.

Electrical Execution.—The New York Court of Appeals has decided that the law providing for the electrical execution of murderers instead of hanging is constitutional.

Port Melbourne (Victoria).—At a recent meeting of the Port Melbourne Council, it was moved "that steps be taken to have the streets of the borough lighted by electricity." The motion was carried.

Kensington Vestry.—At the last meeting of this Vestry the report of the Special Purposes Committee, recommending that the electric light be installed at the Town Hall at an estimated cost of £286, was adopted.

Royal Society.—Among the Papers down for reading at the Royal Society yesterday was one by Prof. J. J. Thomson and G. F. C. Searle on "A Determination of 'v,' the Ratio of the Electro-magnetic Unit of Electricity to the Electrostatic Unit."

Digitized by Google

Brussels.—The Brussels Tramway Company has decided to stop at the end of April the three accumulators which have been running for the past four years in the Rue de la Loi. The reason for the step is said to be the loss entailed by this system of traction.

City of London and Southwark Subway Railway. — The Bill promoted by this Company passed Committee on Friday last, a clause for the protection of the London, Chatham, and Dover Railway Company in the matter of the Clapham-road Railway Bridge being inserted.

Instantaneous Photography by the Electric Spark.—At the recent conference of the Camera Club, Lord Rayleigh gave an account of instantaneous photography by the light of the electric spark, and exhibited photographs of jets of water taken in less than the 100,000th part of a second by this means.

Electrical Engineering Courses.—The electrical engineering class at the Pitlake Institute, West Croydon, which is presided over by Mr. W. Perren Maycock, has been so well supported that it has been decided to hold a fresh term. There is a similar class at the Whitgift Grammar School, of which Mr. Maycock is also instructor.

Fulham Vestry.—At a special meeting of this Vestry, held last week, it was decided by 17 votes to 9 not to apply to the Board of Trade for a Provisional Order to enable the Vestry to supply electricity. At a previous meeting of the Vestry a proposal to provide the Town Hall with an electric light installation was referred back to the Lighting Committee by 9 votes to 5.

The Pollak Battery.—A primary battery for domestic lighting has been brought out by M. Pollak, which is without porous pot. The electrodes are of zinc and lead respectively, and the electrolyte is a solution of copper sulphate. The zinc dissolves and copper is deposited on the lead plate. As the makers replace the battery plates, when they are exhausted, only the copper crystals have to be paid for.

Telegraphing the Result of the Boat Race.—The result of the Oxford and Cambridge boat race, which was finished at 5:6½ p.m., was signalled to New York by the Direct United States Cable, and reached that city at 5:8 p.m. Greenwich time, and was communicated to the Press by telephone a second later. The transmission between Mortlake and New York only occupied one and a-half minutes, and was not equalled by any other Cable Company.

Institution of Electrical Engineers.—The students of the Institution met last Friday at the Sanctuary, Mr. W. M. Mordey in the chair. Mr. Wightman read a paper on "Constant-Current Regulators." A short discussion followed, in which the Chairman, Messrs. Cirlo, Barton, and Bone took part. After giving a vote of thanks to Mr. Wightman for his Paper and to Mr. Mordey for presiding, the meeting terminated. At the next meeting, to be held April 11th, Mr. G. Müller will read a paper on "House Telephones."

Presentation to Mr. Holland Dell.—On Friday evening last a handsome testimonial was presented to Mr. Holland Dell, who was for eight years secretary to the now defunct Electrical Power Storage Company. The testimonial consisted of a fine black marble timepiece, a purse of money, and an artistic illuminated address, and was presented to Mr. Dell by his old colleagues and business friends as a token of their esteem and goodwill. Mr. Dell is now acting as British and Colonial representative to Messrs. Lacombe and Co.

A Correction.—In our last issue, on p. 490, Mr. Harry E. Jones, of the Commercial Gas Company, is reported to have said, "He thought electric lighting companies had taken the cream of the lighting from the gas companies." Mr. Jones now writes us that he made no such statement. What he did say was that "to the extent which they develope he was of opinion the electric lighting companies, *to a certain extent*, take the cream of the gas companies' business away from them," following up this by the statement reported in our Note, that electricity does not compete with gas except for a luxurious style of lighting.

Ferranti String Band Smoking Concert.—On Thursday evening, the 20th inst., a smoking concert was held at the Sir John Falstaff Concert Hall, Old-street, E.C., by the Ferranti String Band, at which about 600 of the engineering staff and *employés* of S. Z. de Ferranti and of the London Electric Supply Corporation (Limited) were present. Many of the engineers of several of the more prominent electric lighting companies of the metropolis were present. The occasion was taken to present Mr. Sparks (Mr. Ferranti's partner) with a handsome address and a tea and coffee service from the united engineers' staff and *employés* of the above firms on the occasion of his approaching marriage.

The Electrolytic Preparation of Aluminium.—The Pittsburg Reduction Company, who are now among the largest producers of aluminium, prepare the metal by electrolysing a bath of Al_2O_3 dissolved in molten aluminium fluoride, the solvent suffering no loss in the operation. The current is conveyed to the bath by carbon cylinders, which form the positive electrode, a carbon-lined pot forming the negative. The oxygen of the alumina goes off at the positive electrode as carbonic acid, wearing away the carbon at the rate of nearly a pound of carbon per pound of aluminium produced. The reduced metal settles to the bottom of the pot, from which it is easily tapped or ladled off, practically free from the electrolyte.

The Thomson-Houston Electric Company.—Some idea of the magnitude and rapid growth of this company may be gathered from the following figures, published by the *Financial News Bureau* of Boston. The company's net earnings last year amounted to over $2,000,000. The authorised common capital of the company is $10,000,000, of which $4,500,000 have been issued. The authorised amount of the Preferred stock is $5,000,000, of which $1,000,000 was issued in July last. The annual business of the company is now in excess of $10,000,000, the net income per month amounting to $250,000. The company employs 2,500 hands at its factory in Lynn, and a force of 150 men at its Boston office. The Lynn pay-roll amounts to $27,000 per week.

Electric Launches at the University Boat Race.—A distinguished company assembled on board the electric yacht "Viscountess Bury," at Messrs. Immisch and Co.'s charging station, Mortlake, to witness the finish of the Oxford and Cambridge Boat Race on Wednesday last. Amongst those present were Viscount and Viscountess Bury, the Hon. Hilda and Mrs. Keppel, T.S.H. Prince and Princess Victor of Hohenstche, the Countess Gleichen, Lord Wantage, Sir Henry Mance, Mr. Irving Courtenay, Prof. and Mrs. George Forbes, Mr. Joseph Smith, and many others. Prior to the advent of the crews a number of very agreeable trips on the smaller launches, "Alpha," "Beta," "Gamma," "Delta," &c., were arranged for the visitors, who expressed great satisfaction at the handiness and steadiness of the boats, which were undoubtedly a feature of great interest to the mass of onlookers present. Messrs. Immisch are to be congratulated upon the success of the arrangements made for the large company assembled.

The Alternate-Current Transformer System in Italy.—We are indebted to the *Bulletin International de l'Electricité* for the following list of Italian central lighting stations on the alternate-current transformer system :—

	Motive Power.	System.	Capacity in kilowatts.
Alzano	Waterfall	Zipernowsky	100
Bagni	,,	,,	15
Bassano	,,	,,	50
Cimeo	,,	,,	150
Lonato	,,	Rivolta	30
Palermo	,,	Zipernowsky	40
Perdehohe	,,	,,	30
Rome (Tivoli)	,,	,,	800
Schio	,,	Oerlikon-Kapp	50
Terni	,,	Zipernowsky	240
Tivoli	,,	Gaulard	6
Treviss	,,	Zipernowsky	60
Taglicozzo	,,	,,	15
Livorno (Leghorn).	Steam	,,	240
Milan	,,	,,	150
Rome	,,	,,	1,440
Syracuse	,,	,,	150
Turin	,,	,,	300
Venice	,,	,,	160

Digitized by Google

Newcastle.—At the last meeting of the Town Council reference was made in the report of the Watch Committee to the offer of the Newcastle and District Electric Lighting Company to place 1,500 candle power arc lights in the open spaces at the Central Station and Cattle Market at the same price as the Corporation paid for the gas; the Committee proposed to experiment with these two large lamps, and if the experiments were successful, arrangements would be made for extending the use of the electric light. This would necessitate the extinguishing of a number of gas lamps, and therefore the Committee was of opinion that it would be much better to be freed from the restrictions imposed by the Gas Company; and they recommended that the 7½ per cent. discount offered under certain conditions by the Gas Company be declined, so that the Committee might be free to light the streets in any manner they pleased. The report was adopted. The cables now laid underground by the Newcastle and District Electric Lighting Company are sufficient to supply 5,200 10 candle-power lamps. There are in all 14,200 yards of cable laid.

Edinburgh.—A conference was held at Edinburgh on Tuesday between Lord Balfour of Burleigh and Mr. Courtney Boyle and a deputation of the Edinburgh Town Council on the subject of electric lighting. The Lord Provost said the Corporation was anxious to keep the management of the whole thing in their own hands. They contemplated applying for a Provisional Order as soon as possible, and would have done so before, but there was some doubt as to who was the local authority under the Act. Lord Balfour of Burleigh said that, as far as Edinburgh was concerned, there was no further doubt as to who was the local authority. Mr. Courtney Boyle said he thought the companies, if they had to wait till next spring, ought to be given some preference by the Corporation over any other companies coming forward later. The Conference then proceeded to consider in private the clauses of the Electric Lighting Amendment Bill. Later in the day representatives of the Scottish Electric Supply Company and the Scottish House-to-House Supply Company had a conference with Lord Balfour and Mr. Courtney Boyle. Mr. Graham Murray, for the former Company, pressed for an inquiry, the date of which might be postponed until the Town Council had decided what to do. Mr. Colquhoun, of the latter Company, pressed for an immediate inquiry, if any. At the conclusion of a lengthy discussion, Mr. Courtney Boyle said that it might be possible that the Town Council, in taking up their present position, really represented the views of the ratepayers, who, perhaps, did not want the electric light at all.

Electricity in Wine Vaults.—The offices and champagne vaults of MM. Chandon et Cie., at Épernay, have recently been provided with a very interesting electric light and power installation. The plant comprises three Babcock and Wilcox boilers, three 60 horse-power Bréguet engines, and six dynamos. Three shunt-wound 12-unit Bréguet machines supply the current for the incandescent lighting and storage batteries. Two compound-wound Manchester machines, giving 250 volts and 55 amperes, supply the current for power purposes, and arc lights are run off a third Manchester dynamo (70 volts × 200 amperes). The incandescent lamps are mostly of 16 candle-power, and in the overhead portion of the establishment are fixed in the ordinary manner. In the vaults the wires are bare and of silicium bronze, the lamps being attached to the wires wherever wanted by flexible connectors. The fall of potential in the circuits near the dynamos is limited to two volts; but in those feeding the distant vaults and outhouses a maximum loss of 12 volts is allowed for, the E.M.F. of the dynamos being regulated by varying a resistance in the shunt-circuit. The motors, which are of the Raffard type, with Pacinotti-Gramme armatures, are used for a variety of purposes, such as working lifts, pumps, bottle-rinsing machines, &c. Several champagne establishments are putting in electric light and power plants, owing to the many advantages attaching thereto, such as reduction of temperature in the wine vaults, and the time saved by employing electric motors in the various operations of champagne making and bottling. MM. Chandon et Cie., we should add, have nearly 10 miles of underground vaults.

Gulcher's Thermo Battery.—Mr. R. J. Gülcher, the designer of the Gülcher dynamo, has lately brought out a new type of thermo-electric battery. The electro-positive electrodes are hollow, and consist of chemically pure nickel tubes. Joined to these are the electro-negative cylindrical bars, which consist of an alloy of antimony. Each battery consists of a U-shaped channel resting upon the base, and closed at the top by a slate slab, into which the nickel tubes are fixed in two rows. The top of these tubes is provided with a perforated collar of soapstone, so that the gas which passes up from the U-shaped channel is emitted from these perforations and heats the junction of the two metals directly above the perforators. Above the soapstone collar there is a second one of brass, which protects that part of the antimony alloy connected with the nickel. The negative electrode, which rests on the top of the nickel tube, turns outwardly and downwardly, and is continued in a flat copper strip, which serves as a cooling medium, and also as a connection to the next element. Each element has its own gas outlet and a separate heating flame. As the flames are very small, enough air can get at each flame to effect combustion in the same way as in the Bunsen burner, and as a consequence neither soot nor carbonic oxide gas is formed. The following data are given in the *Elektrotechnische Anzeiger* concerning the consumption of gas and electrical energy developed by a thermopile of 50 elements. The consumption of the battery mounts to about 8 cubic feet of gas per hour. Its E.M.F. is 4 volts, and its internal resistance 0·48 ohm. The manufacture of this battery has been taken up by the well-known firm of Julius Pintsch, of Berlin.

Electricity and Photo-Engraving.—In commercial photo-engraving, zinc etching, and the gelatine relief process, it is absolutely necessary, says the *Electrical World*, that the exposure be properly timed. Any increase in the duration of the exposure will cause what is termed an "overprint." On being placed in charge of the relief gelatine process some years ago, Mr. W. A. Blomgren, of Blomgren Bros., Chicago, found that the best of assistants would sometimes fail to remove the plate at the correct time, causing an annoying loss of time and material: so he devised an electric alarm, which has proved so satisfactory that the company have one connected to each of their three or more copying cameras. The device consists simply of an ordinary clock movement, having a special form of dial with sixty points indicating minutes traced thereon, around which revolves one hand in unison with the movements of the clock, while a second hand, insulated from the other, is moved to any desired point at the will of the operator. Both hands have platinum points that make a rubbing contact when the minute hand passes over the quiescent hand. When an exposure is to be limited to, say, six minutes, the still hand is moved six minutes in advance of the minute hand, and when the latter reaches that point it closes the circuit and causes several strokes of the bell to ring out while rubbing past, and notifying the assistant to change the plate. A further improvement of especial value to the operator temporarily left without an assistant is a small coil and armature placed above the inner face of the lens within the camera, and connected in the circuit with the clock and bell. When the circuit is open, a shutter or blind is lightly supported by the armature of the coil, and is released and allowed to fall on the closing of the circuit, thus preventing further exposure.

Paddington Vestry.—At a special meeting of this Vestry on Friday last, the question of the electric lighting of the parish was considered. Colonel H. C. Barchard proposed the adoption of the report of the Lighting Committee, which recommended that the application of the Kensington and Knightsbridge Electric Lighting Company should be assented to. But if the Vestry considered the draft regulations now being prepared by the Board of Trade to do away with the objections to the high-pressure system, then the committee was of opinion that the application of the Metropolitan Electric Supply Company might be considered. As the cost of lighting the streets with electricity would be very greatly in excess of gas, the committee did not feel justified in recommending it. Mr. H. H. Mills proposed, as an amendment, that the Provisional Order be amended, inasmuch as the draft Provisional Order prepared by the committee did not secure to the ratepayers such advantages as they were entitled to receive as a consideration for the very valuable concession involved in

Digitized by Google

the granting its assistance to a company to obtain an Order for lighting the parish. It was finally agreed to adjourn the further consideration of the matter.—At a second special meeting of the Vestry, held on Tuesday, the report of the Electric Lighting Committee was again under consideration. Mr. Hannay said in the district which he represented (Bayswater) a strong feeling was manifesting itself against the Vestry at the delay which had occurred in this matter, and the inhabitants were very desirous of having the electric light under reasonable conditions. They were about to hold a public meeting on this subject. The Vestry had had the matter under consideration nearly two years, and, as far as he could judge, they were now as far from arriving at a decision as they were at the beginning. Finally, the whole report was referred back to the committee for re-consideration and report.

The Indian Telegraph Service.—The report of the Indian Telegraph Department for the past year shows a surplus of Rs.19,80,245, representing a dividend of 4·45 per cent., which is the highest yet recorded. The principal feature of that year was the increase in the number of private messages, which have gone up from 1,860,390 to 2,115,863, producing a revenue of Rs.22,31,514, as against Rs.19,81,814 in the previous year. The capital expenditure was Rs.17,43,620, raising the total capital of the department to Rs.4,45,21,203. The working expenses were Rs.43,42,231, and the gross receipts, including the value of State messages, were Rs.63,22,476. The actual profits united give a net dividend of 2·15 per cent., as against 1·389 in the previous year, and 0·303 in 1887. The mileage open was increased during 1889 by 1,568 miles, and the wire mileage by 6,137 miles. For field telegraphic operations 105 miles of wire were supplied for the Sikkim expedition and 12 offices opened, 206 miles for Hazara and 23 offices opened, and for the Chin expedition 70 miles, three offices being opened. In the Sikkim expedition a telegraph office was opened which enjoys the distinction of being the highest in the world. It is situated at Bhutong, at an altitude of 13,500ft., nearly two and three-quarter miles above the level of the sea. In the Hazara campaign, ground wires, enabling a temporary line to be rapidly laid, were used for the first time in India, and with such marked success that the Commander-in-Chief expressed special approbation of it, observing that the enterprise with which the line was carried forward with the advance and its efficient working throughout were specially commendable. In regard to accidents, the report states that the total number of stoppages during the year was 1,908, involving 38,729 hours of delay, for 4,105 of which malice was responsible, 2,008 were caused by birds and other animals, 8,107 by falling trees, 644 by lightning, 5,215 by cyclones, and 4,280 by preventable defects in lines and cables.

The Seely Electric Light Cable Connector.—In the jointing of a large number of the underground electric light cables of New York a tubular form of connector has been employed which was designed by Mr. J. A. Seely, of the Seely Manufacturing Company, and which was specially devised to be used in connection with lead-covered cables. The tube, as made for taking off a branch circuit, has the general form of a T, but its parts are slit to facilitate the connection with the wires. The wires when once adjusted are sweated in by solder, which flows into the slits of the joint and forms a solid connection and good electrical contact. The ends of the tube, which abut against the fibrous insulation of the conductors, are double bevelled and rounded to prevent abrasion of the insulation. This obviates a fault in the ordinary T-couplings, which are usually made rough, and it has been found that the square ends are sometimes armed with a burr, which cuts through the insulation, thus admitting water and causing a ground or a short circuit. In the operation of making a connection a section of the lead sheathing is removed from the main. The fibrous insulation is then cut away or tapered toward the middle of the opening, and finally enough of it is entirely removed to expose the length of conductor which is to be covered by the joint. The tube is then passed under the wire and brought up until it surrounds the same, when, by the use of a pair of pliers, it is bent up and around the conductors until the edges of the slit nearly meet. The branch, the end of which has been exposed, is then pushed into the lateral stem of the joint, and the pliers again used, if necessary, to bring up the sides of the tube against the wire. The joint having been placed in position, solder is poured into the slits, which flows around the conductor and makes good contact between the parts, besides sealing the joints. This done, the joint is wrapped with suitable insulating tape or compound. The rounded edges prevent any abrasion of the insulating material. Although specially designed for use in connection with lead-covered cables, the connector is equally well adapted to other conductors, and for general purposes.

Electric Lighting for Railway Stations.—An interesting Paper was contributed by MM. Sartiaux and Weissenbruch to the last Railway Congress, giving an account of the general experience in the electric lighting of railway stations. The authors collected a large amount of valuable information as to the cost of the system, from which we extract a few particulars. The cost of electric lighting is steadily declining, particularly in those items such as interest and depreciation. Even in the matter of maintenance, the expense seems to be decreasing, as is shown by a comparison of two years' working expenses of a 40-light Brush installation at the Waverley Station (Edinburgh) of the North British Railway. With 33 lamps at work for 41,884 hours between July and December, 1884, the total cost was £484. 6s. 6d., or at the rate of 2·77d. per lamp-hour. In the corresponding six months of 1886 the cost of the same number of lamps running 56,174 hours was £411. 0s. 9d., or at the rate of 1·75d. per lamp-hour. The cost of carbons and of the renewal of incandescent lamps is always a heavy item. At the Bebra Station of the Prussian State Railway, it is reckoned at nearly half the total working charges; at the Western Station in Vienna it is 39 per cent.; at Feldkirch 33 per cent.; at Venlo 25 per cent.; on the Northern Railway of France 13 to 24 per cent.; at the Northern Station, Brussels, 10·5 per cent. In spite, however, of the gradual reduction of the cost of electric lighting, and of the high price of gas abroad, a very considerable increase of outlay is required for the former. In all cases, however, there is a greatly increased amount of light. For instance, it is calculated that had the St. Lazare Station in Paris been lighted with gas the cost would have been only two-fifths of what it is, but the light would only have been one-fifth. At Bebra the substitution of electricity for gas has doubled the cost, while the illumination has been increased thirty-fold. The authors made a calculation of the respective values of gas and electricity when used as lighting agents in various ways. According to this, the incandescent lamp of 16 candle-power consuming 50 watts is the equivalent of a gas burner using 5·3 cubic feet and giving 16 candle-light. In these conditions, 1,000 cubic feet of gas equal 8,490 watt-hours. In the Paris Exhibition there were some large burners consuming 157 cubic feet of gas per hour. These probably had a mean intensity of 9 candles per cubic foot, or 1,400 candles in all. A continuous-current arc lamp of this mean intensity would produce a greater illumination on the ground, and would not require more than 750 watts. Under these conditions, 1,000 cubic feet of gas is equivalent to 4,700 watt hours. The price per watt-hour varies with the number of hours of lighting, as is shown by the following figures supplied by the Northern Railway Company of France. At their Calais Station, the number of hours lighting per lamp per annum is 500; the number of lamps of 25 amperes and 45 volts in use, 8; and the price per 1,000 watt-hours, 10·42d. The figures for other stations are as follows:—La Chapelle: Hours of lighting, 1,010; number of lamps, 8; price, 16·3d. La Chapelle sorting station: Hours, 3,582; lamps, 8; price, 5d. Lens: Hours, 5,333; lamps, 7; price, 5·3d. St. Martin: Hours, 3,729; lamps, 6; price, 4·7d. Condekerque: Hours, 3,741; lamps, 4; price, 6·9d. Longueau; Hours, 3,924; lamps, 5; price, 5·4d. Hirsin: Hours, 4,288; lamps, 6; price, 1·46d. The author's calculations, which were embodied in tables and diagrams, show that the cost of incandescent lighting does not fall below that of gas at 4s. 1d. per 1,000 cubic feet until the lighting is prolonged beyond 3,250 hours. On the other hand, with arc lighting in large stations, electricity is cheaper for a given illuminating power than gas at 1s. 7d. per 1,000 cubic feet when the period of lighting exceeds 2,000 hours, and is equal to gas at 1s. 1½d. for 3,000 hours.

Digitized by Google

MAGNETISM IN IRON AND OTHER METALS.*—XI.

BY PROF. J. A. EWING, F.R.S.

(*Continued from page 492.*)

§ 54.—Damping and Calibration of the Ballistic Galvanometer.—In some uses of the ballistic galvanometer it is important that there should be little "damping"—in other words, that the swinging of the needle should subside very slowly. But in magnetic observations of the kind now under description—when what we deal with is merely the comparison of different ballistic effects—this is not necessary: it is, in fact, desirable, as a matter of convenience, to have a good deal of damping, provided always there is not so much as to prevent the throws from being proportional to the changes of magnetic induction. To test whether this condition is satisfied, a series of successive currents of increasing strength should be made and broken in the primary coil of § 53, while the corresponding throws are observed and compared with the strength of the primary current, to see that the two vary together. Another plan is to have a small induction coil (in circuit with the ballistic galvanometer) slipped upon a long bar magnet. Pull the coil quickly off the magnet, and observe the throw; then reduce the number of turns in the coil by unwinding one or more of them, and observe the reduced throw when it is again pulled off, and so on, until the number of turns and the throw is greatly reduced. The observed throws should be proportional to the successive numbers of turns in the coil.

To save time between ballistic readings, it is convenient, especially when the damping is not very considerable, to follow Rowland's plan of including in the secondary circuit a small coil slipped upon a magnet.† By pulling it off or slipping it on at the right moment, while the needle is swinging, the observer may, with a little practice, succeed in giving the needle a check, which brings it quickly to rest. Care must, of course, be taken that this coil is not moved while observations are being made.

§ 55. Ballistic Tests of Rings and Rods.—Fig. 23 illustrates the ballistic method as applied to an iron ring. The ring A is

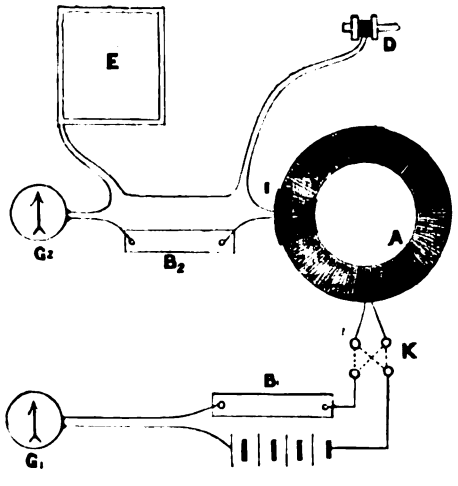


FIG. 23.—Diagram of Connections for Ballistic Method.

wound all over with a primary or magnetising solenoid, the current in which is measured by G_1, and can be subjected to sudden variations by putting in or drawing out the plugs of the resistance-box B_1, or can be made, broken, or reversed by the key K. G_2 is the ballistic galvanometer, in circuit with a secondary or induction coil (wound over a part or the whole of the ring), with the resistance box B_2, by which the amount of the throws may be varied, the earth coil E and the small coil D which is used to check the swinging of the needle. In addition to the parts shown, it is convenient to include in the primary circuit the arrangement of liquid slide and rapid reversing key for demagnetising by reversals, as explained in § 42. By this means we can ensure that the ring is in a magnetically neutral state to begin with.

To test the permeability and determine the force of the magnetisation curve, one or other of two plans may be followed: (1) *By Steps.* A weak current may be applied and the throw noted, then the resistance in B_1 may be suddenly reduced, and the additional throw noted, and so on, each throw measuring the magnetic effect of a sudden increase in the magnetising current. The whole magnetism acquired at any stage is then to be estimated by summing up the throws. The same process evidently allows us to trace the individual and cumulative effects of successive diminutions in the strength of the magnetising current, and thus to trace the magnetisation curve throughout any step-by-step process of applying, removing, or reversing magnetising force. This is its advantage: on the other hand it has the practical drawback that if an error is made in measuring the throw at any step it is carried forward and affects all the subsequent values of the magnetisation. (2) *By Reversals.* Another plan is to suddenly reverse the current in the primary coil. Half the throw is then taken as measuring the actual magnetisation. Breaking the current also allows the permanent magnetism to be calculated by showing the amount that disappears in the withdrawal of the magnetic force. As to the effect of each reversal, care must be taken that the currents are progressively increased, and even then the assumption that half of that effect measures the total magnetism is not quite accurate, especially in the case of hard iron or steel, which is less ready to be magnetised by a force of one sign after a force of the opposite sign has been applied than if the opposite force had not acted. In soft iron the curve of magnetisation as determined by this process of reversals is not materially different from the curve determined by the process of steps.

In applying the ballistic method to long rods or ellipsoids, or other specimens with ends, either of these processes may, of course, be used, and in addition a third plan is practicable—namely, to have the secondary coil arranged so that it may be suddenly slipped off the magnetised piece. The effect of slipping it off is to reduce the lines of induction within it to zero, provided the coil is at once drawn far enough away to get practically out of the magnetic field, and the throw of the galvanometer therefore measures the whole magnetisation which existed just before the coil was removed. This method is often useful, but it must be borne in mind that the mechanical disturbances caused by pulling off the coil may, especially with soft iron, alter very seriously the amount of magnetism associated with any assigned value of the magnetic force. This will be evident later when reference is made to the effects of vibration on the magnetic susceptibility of iron. We cannot, therefore, use this plan to trace the effects of successive currents of ascending and descending strength. After the step-by-step process, however, has been applied to a long rod, slipping off the coil affords a useful test of the accuracy with which the summation of the steps has been carried out.

§ 56. Calculation of B from Ballistic Measurements.—We have seen how the ballistic measurements serve to determine Q, the whole number of lines of induction within the secondary coil. If the secondary coil is wound close upon the iron, very nearly the whole of these lines lie within the iron, and we then have $\mathbf{B} = \frac{Q}{S}$, where S is the area of cross-section of the iron in square centimetres. If, however, the area of the secondary coil includes any sensible air space (or other non-magnetic space) in addition to the iron, a suitable deduction must be made from Q before dividing by the area of cross-section of the iron to find **B**. Thus if the secondary coil is outside the primary, and the mean area of the primary coil is S′, we shall have $(S' - S)\,\mathbf{H}$ lines enclosed within the secondary coil, but outside of the iron, and this number will fall to be subtracted from Q. Even when the secondary coil is wound directly upon the iron, its mean area is necessarily somewhat greater than the section of the core, and there is consequently a small correction to be applied (namely, the difference of these areas multiplied by **H**), but the amount of it is generally insignificant.

(*To be continued.*)

* All rights are reserved.

† *Phil. Mag.*, Vol. XLVI., 1873, p. 147.

Digitized by Google

ELECTRO-MAGNETIC RADIATION.*

BY PROF. G. F. FITZGERALD, M.A., F.R.S.

The Professor began by explaining how small forces, if repeated at regular intervals so as to give rise to a series of rhythmic impulses, might be made to produce great and destructive effects. By suitably selecting the period of vibration, so as to agree with one of the periods of vibration of any body, these rhythmic impulses might be made to exert destructive effects on that body; and, on the other hand, damage to any given structure might be avoided by selecting periods to which it was incapable of responding. This principle, that certain bodies or structures were capable of absorbing periodic impulses of certain definite periods, being thrown by them into very intense vibration, was known as the principle of resonance. Prof. Lodge, in a lecture on "The Leyden Jar," delivered at the Institution last year, had arranged his apparatus so as to make the period of the alternating discharge as great as possible, in order that each wave might be separately distinguishable. The lecturer then proceeded to explain that for waves in any given medium, which in the case of Prof. Lodge's and his own experiments was the ether, the wave-length was inversely proportional to the vibration period. The length of the waves in Prof. Lodge's experiments was about 600 miles.

Ether waves which would produce the highest audible note would have a length of five or six miles, but what he required for making the presence of electro-magnetic vibration visible was a wave length of from two or three, up to ten or twelve feet. The period corresponding to this would be about the hundred-millionth of a second. Waves giving the highest audible note would take about three hours to make as many vibrations as these would in a second, and the waves in Prof. Lodge's experiments would take about a fortnight.

The lecturer then exhibited a large Hertz oscillator which was to be employed in setting up the electro-magnetic vibrations. This consisted of a pair of large metallic plates suspended from the ends of a long glass rod. From the near sides of the plates projected wires terminating in brass balls, the distance between which was capable of being varied by sliding the plates along the rods. The two plates were then connected with the terminals of a Ruhmkorff induction coil, and sparking set up between them. The indicator employed to detect the presence of electrical oscillations consisted of a long conductor of copper wire, having its ends furnished with brass knobs, brought sufficiently close together to allow sparking to take place between them when electrical oscillations were set up in the wire by the ether waves radiating from the oscillator.

The lecturer then explained the nature of the circumstances which determined the period of the electrical oscillation by comparison with the vibrations of a tuning-fork. The vibration period of a tuning-fork could be diminished either by increasing the stiffness of the prongs, or by diminishing their mass, and, similarly, the period of an electrical oscillation could be diminished by diminishing the capacity of the conductor in which the oscillations took place, or by diminishing the air-space across which sparking occurred; a small electrical capacity in the conductor corresponding to stiff prongs in the fork, and a small air-space corresponding to small mass in the prongs. The sparks in the secondary circuit or detector were too minute to be seen at a distance; but the lecturer was able to indicate their existence to the audience by means of the discovery which he had recently made, that if the air-space terminals were connected through a delicate galvanometer, the galvanometer was deflected whenever sparking occurred across the air-space. He had not at present succeeded in arriving at any satisfactory explanation of this phenomenon, but it afforded a convenient means of demonstrating the existence of the sparks to an audience. The lecturer explained that it would not do to connect the terminals of the secondary circuit, or resonator, as he called it, through the galvanometer, as if that were done no sparking would take place. He therefore had to adopt an arrangement in which a small subsidiary spark was given across an air-space with its terminals connected in this manner.

It was then shown that when the length of the secondary circuit was doubled the sparks became smaller, which was indicated by the diminution in the disturbance of the galvanometer. This result was in contradiction to all the theories of electro-magnetism, with the exception of the Faraday-Maxwell theory that electro-magnetic disturbances were propagated by ether waves. According to this theory it was to be explained as due to diminished resonance, the resonator in the first case having, so to speak, been tuned into synchronism with the oscillator, and the addition of a greater length of wire to the resonator throwing it out of synchronism. The lecturer then illustrated the principle of interference of vibrations by communicating vibrations of large amplitude to the free end of a cord suspended from the roof, and showing, in the first place, that the wave, after travelling up the cord, was reflected on reaching the fixed end, and travelled down again. He then agitated the lower end of the cord rapidly and regularly upon which it separated into segments separated by points of rest, or nodes, and the centres of which were points of maximum amplitude of vibration, or loops. This was explained to be due to the interference of the direct and reflected waves. The fixed end of the cord, or point of reflection, was a node, and the lecturer showed that similarly the point of reflection of an electro-magnetic wave was a node, or point of no vibration. This was effected by placing a sheet of metal immediately behind the resonator, which had previously been sparking under the influence of the oscillator. This reflected the waves, so that the resonator was close to the point of reflection of each wave, and this position was shown to be a nodal one by the fact that sparking at once ceased in the resonator.

The lecturer then referred to Hertz's fundamental experiment demonstrating the existence of a series of points of maximum sparking, or loops, separated by equal distances, each double the distance of the first loop from the reflecting surface. This proved conclusively that electro-magnetic radiation took time for its propagation, as was required by Maxwell's theory.

The lecturer then again threw the suspended cord into vibration, but this time by moving its free end rapidly in a horizontal circle instead of backwards and forwards in a horizontal straight line. This gave to each point of the cord a combined motion of oscillation and rotation which he compared to the electric and magnetic forces respectively in an electro-magnetic vibration, observing that the magnetic and electric forces, like the rotary and oscillatory motions of the points of the cord, were invariably at right angles to each other. It was then pointed out that in the case of a single wave travelling along the cord, the crest of the wave, or point of maximum displacement, was also the point of maximum rotation, while in the case of a series of direct and reflected waves, following each other in rapid succession, the nodes, or points of no displacement, became the points of greatest rotation. It was exactly the same in the case of the electric and magnetic forces, the two attaining their maximum and minimum values together at a distance from the oscillator—that is to say, in the case of a single wave; while near the oscillator—that is, in the case of a series of waves surging backwards and forwards, the magnetic force is a maximum when the electric force is a minimum, and *vice versâ*.

The lecturer then observed that Maxwell had deduced from his theory that light is an electro-magnetic disturbance propagated through the ether, the conclusion that sunlight ought to repel any body which either absorbed or reflected it. The effect, if it existed, would be exceedingly small, which was probably the reason that it had not as yet been possible to detect it; but a similar effect could be observed by suspending a metallic conductor in front of a powerful electro-magnet excited by an alternating current. The conductor absorbed part of the electro-magnetic radiation falling upon it, and also reflected a portion, so that it ought to be repelled by the magnet. This was shown to be the case by suspending a half-crown, with a mirror attached to indicate its motions, in front of an electro-magnet excited by an alternating current from a dynamo in the basement of the Institution. The coin was seen to be repelled as soon as the current was turned on.

Referring to the nature of the ether, or medium by which electro-magnetic waves are transmitted, the lecturer pointed

* Abstract of a lecture delivered at the Royal Institution, March 21.

Digitized by Google

out that it could not be of the nature of a solid, because rotation could not possibly continue for any long time in the same direction in a solid body; and in the case of the transmission of electro-magnetic waves, continuous rotation of the transmitting medium could go on for hours at a time.

The fact that electro-magnetic radiation obeys the same laws of reflection as the other forms of radiation known to us, viz., light, heat, and sound, was demonstrated by placing a small oscillator with its air-space on the focal line of a vertical metallic parabolic cylinder, and a resonator, in the same horizontal plane, on the focal line of a second metallic parabolic cylinder, having a common axial plane with the former one. The resonator was then seen to respond to the sparking of the oscillator, although the distance was too great for it to have done so without the intervention of the mirrors, and merely by the action of the waves transmitted directly. A wooden frame with a number of parallel wires stretched upon it was then interposed between the two mirrors perpendicular to their common axial plane. It was then found that as the frame was rotated, a position could be found in which the resonator would not respond to the oscillator, but when turned through a right angle it produced no effect, the waves traversing it without hindrance. Now this framework would absorb electro-magnetic vibrations parallel to the wires, but not those at right angles, so that the experiment showed that the electro-magnetic vibrations were polarised—that is to say, were all parallel to one plane.

The growth of the electric and magnetic forces was then illustrated by a series of diagrams, which were first thrown upon the screen in slow succession, and then made to follow one another with great rapidity by means of a kind of zoetropic apparatus, designed by the lecturer, thus illustrating in a very striking manner the nature of a series of electro-magnetic waves.

Returning to the consideration of the nature of the medium by which electro-magnetic waves are propagated, the lecturer exhibited a beautiful experiment to show that a vortex in a liquid could be thrown into vibration exactly as if it were a solid. A large glass jar, full of water, was provided, with a small aperture at the bottom. The lecturer then opened the tap at the bottom, and threw the liquid into rotation about a a vertical axis, by stirring it. A columnar vortex was thus formed, extending from the top to the bottom of the water, and was made visible by throwing some quinine into the liquid, and illuminating it by a beam from an electric lantern. The jar was then shaken, and the beautiful fluorescent vortex was seen to pulsate just like an elastic solid, the waves travelling up and down between the two surfaces of the liquid from each of which they were reflected. The lecturer then suggested that the ether might be supposed to be a liquid containing a number of vortices of this kind, for Sir William Thomson had shown the possibility of the existence in a liquid of stable columnar vortices with their axes inclined at all possible angles. Vortex rings threading between these stable vortices would represent material atoms. This theory would explain all the phenomena of nature as being due to different movements in space.

SWITCHBOARD AND REGULATORS OF THE ST. JAMES' AND PALL MALL ELECTRIC LIGHT COMPANY.

The new switchboard and regulating apparatus now being erected at the Duke-street station of the St. James' and Pall Mall Company has been constructed by Messrs. Latimer Clark, Muirhead, and Co., of Westminster, to the designs of Mr. S. T. Dobson, chief engineer to the Company. The lighting of the St. James' and Pall Mall district is carried out on the three-wire low-tension system, on each side of which the dynamos are run coupled up in parallel. The regulation of pressure is obtained by driving the engines at a constant speed, and varying the resistances in the shunt circuits of the dynamos. The drawings show the front and side elevations of the main switchboard and regulators and below the general plan of connection.

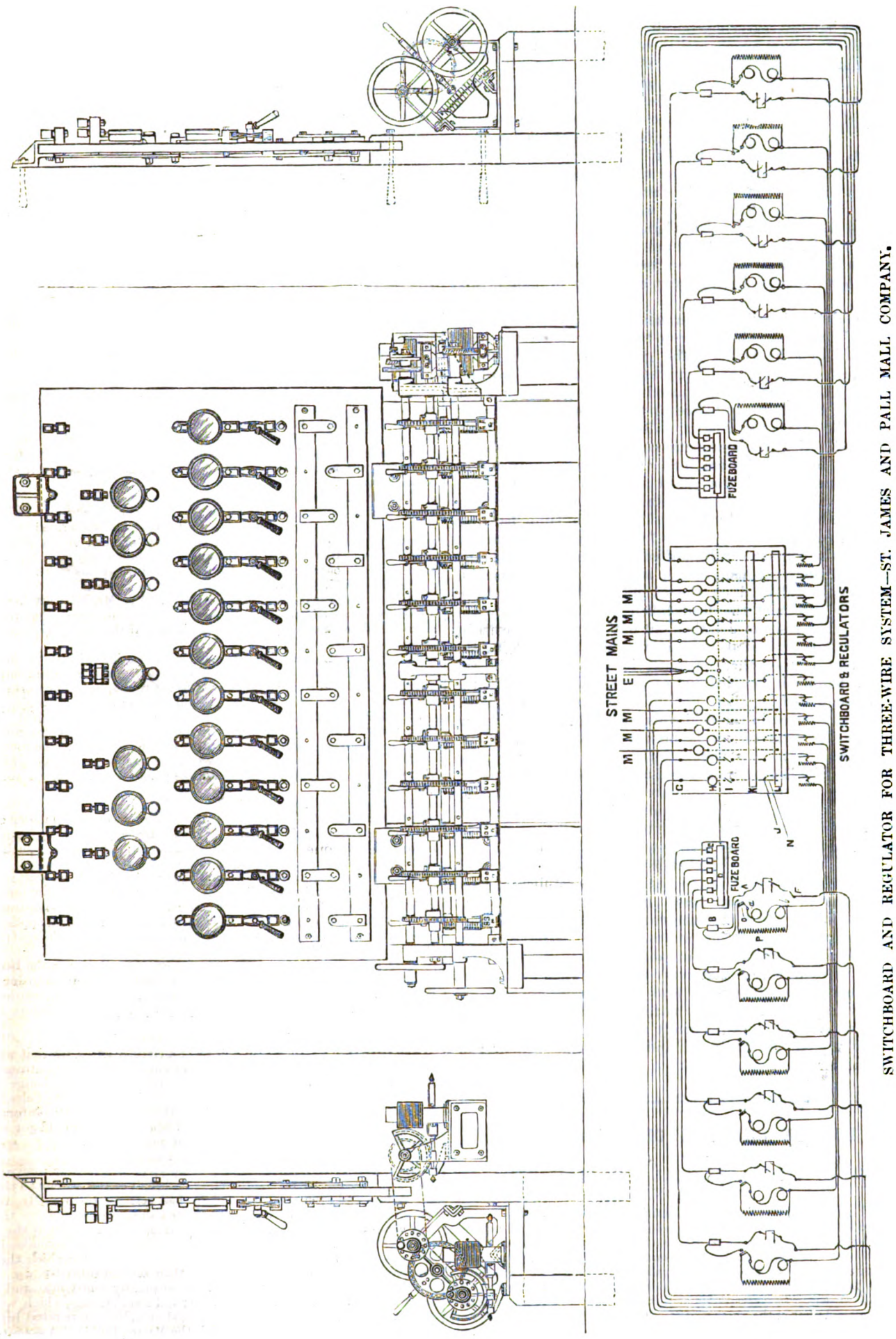
The main board is of massive slate supported by an oak framing on the eastern wall between the two lines of machinery, and is constructed for 12 machine circuits; ten machines having an output of 1,000 amperes each, and the remaining two of 125 each, all the machines being capable of working up to 125 volts pressure if required, for battery work. The connections to the main switchboard from the machines consist of heavy insulated cables, each of one square inch sectional area, carried through porcelain insulators, supported on brackets bolted to the overhead girders.

Following out the circuits on the plan, the cable is carried from the left-hand terminal A of each machine to an automatic cut-out, B, mounted on the top of the machine, and designed so as to break the main circuit when required, the cut-out being held by the current itself, and thrown out by gravity as soon as the current falls to about 30 amperes on shutting down. From the cut-out B the cable is carried overhead to a main fuse-board, C, a line of six main fuses being mounted on a separate board on each side of the large switchboard. A collecting-bar, D, joins each set of six fuses, and these two bars are connected together and led through an ampere-meter, E, to the middle or intermediate main which supplies the six middle mains of the outer circuit. The right-hand terminal F of each machine is connected by a cable carried overhead to one of the 12 terminals G at the top of the main switchboard. From each of these terminals a gun-metal bar is carried vertically down to the switch, one for each machine, and on this bar is mounted a soft iron needle and scale enclosed in a suitable box to form an ampere-meter, H. The lower extremity of the bar forms the top contact of the switch I, the switch itself being built up of copper spring plates to ensure a sound contact. From the lower terminal of the switch the connection is carried down to a stud, J, placed midway between two horizontal bars of copper, K K, L L. From each of these two bars massive copper straps pass up the back of the board, through ampere-meters, M, to supply the six outer pairs of mains. From each of the studs J, placed between the bars K K, L L, a copper strap, N, can be shifted to one bar or the other, and bolted up firm, thus placing any machine on one side or the other of the three-wire system, as required. The use of plugs was abandoned as being unsuitable, for each machine line has to carry up to 1,000 amperes. The connections to the back of the slate are made by means of screwed studs, surrounded by a copper sleeve of slightly greater depth than the slate, so that when the nut and washer are screwed home on the sleeve, a sound contact is made, without bringing any pressure to bear on the slate. All connections are easily accessible from behind.

The machines are all separately excited from the main circuits to ensure quick working. It will be seen that in changing the machines from one side of the system to the other, the currents in the armatures are reversed, owing to one pole being connected permanently to the intermediate main; but the advantage of having only two omnibus bars for a three-wire system is so great, that this object has been obtained by automatically reversing the shunt connections by means of the same connecting straps N on the main board. Thus one end of each shunt, *a*, is connected through a switch, O, placed upon the side of each machine, to the cable leading to the main fuse C. This switch is so constructed that before breaking the field-magnet circuit it throws into parallel with the shunt-coils a non-inductive resistance, P, of German silver wires of equal resistance to the magnet coils, so that on breaking the field circuit the extra current induced discharges harmlessly through this resistance. The other end of each shunt, *b*, is led to its section of the main regulator, and from thence to one of the centre studs J, situated between the two omnibus bars, K K, L L. Thus in reversing the connecting strap N, so as to connect the machine to the right or left-hand outer main, the shunt connection is reversed at the same time so as to magnetise the field coils to suit the change in the direction of the current.

The engines are arranged to run on their centrifugal governors to obtain as far as possible a constant speed; the rest of the regulation is done on a specially designed regulator at the foot of the main switchboard. This regulator is formed of a skeleton frame tied together by two long horizontal angle irons and a fixed steel spindle. Across the angle irons are mounted

Digitized by Google



SWITCHBOARD AND REGULATOR FOR THREE-WIRE SYSTEM—ST. JAMES AND PALL MALL COMPANY.

Digitized by Google

12 commutator sections, one for each machine, each commutator being connected to a separate resistance of 14 steps for insertion in the field-magnet circuit. On the fixed spindle are 12 rocking handles, carrying, but insulated from, a bent contact piece of copper, which makes connection on the side of each commutator, and a collecting strap parallel to it. The shifting of each handle backwards or forwards puts in or cuts out resistance in that machine. Each handle is fitted with a spur wheel, and on each side of the fixed spindle is a rotating spindle. The back spindle regulates the right-hand side of the mains, the front spindle the left-hand side; and according as the machine is working on one side or other of the mains, the spur wheels are connected by fast and loose pinions sliding on feathers on either shaft to be worked by that shaft. At one end of the regulator two large hand-wheels 15in. in diameter work the two shafts, and in front are the two main voltmeters, not shown in the drawing. The other ends of the shafts are fitted with automatic driving gear, consisting of motors and relays.

The regulating handle for each machine comes directly under the line of connections belonging to that machine on the main switchboard, and the whole of the gear is arranged to obtain the greatest simplicity and symmetry possible. In working the circuit the engine is first started and the brushes put on, the machine being already bolted up to work on one side of the circuit or the other; the exciting switch is then put on and the field excited. Next the automatic cut-out is put up by hand, where it is held in position by a trigger until supported by the main current, and the speed increased by opening up the steam valve, the pressure being noted on a pilot lamp on the main board, placed side by side with a lamp fed from the circuit. A single lamp suffices for use on all the machine circuits, as the contact can be shifted. When the two lamps agree in brilliancy the main switch is closed, and the machine swings exactly balanced on the circuit. The steam valve is then opened up, and the load taken on until held by the governor. The resistance is then cut out of the field coils by the main regulator, and as soon as the machine is doing the same current as the other machines in parallel with it, the regulator handle is coupled up to its spindle, and all the machines regulated together. For shutting down, the resistance is gradually inserted in the field coils, next the engine is shut down until the main circuit is broken by the automatic cut-out, the main switch is shut off, then the exciting current switched off, the brushes raised and the engine shut down.

By having the machines separately excited the connecting rods of the engines may be disconnected, and a small current passed through the armature. The machine will then run as a motor, sufficiently slow and steady to allow of the commutator being faced up by means of a slide-rest bolted on to the bed-plate. The battery plant at the station is separately connected to the mains with its own gear, and is charged by the two smaller machines, which are then cut off the main switchboard by removing their connecting straps. These batteries supply the night lights, and work in and out between the large machines as required, so that every machine when switched in works at once at an economical load by replacing the current previously supplied from the batteries. The whole gear is designed for a quick-working direct system, the Company preferring to rely on the perfection and subdivision of their running plant for a clean record than to sink a large capital in batteries.

LONDON CHAMBER OF COMMERCE.

MEETING OF THE ELECTRICAL AND ALLIED TRADES' SECTION.

At a special general meeting of the Electrical and Allied Trades' Section of the London Chamber of Commerce, held on the 26th inst., at Botolph House, Eastcheap, Mr. Crompton in the chair, it was announced that a letter had been received from Mr. Hammond calling attention to the change which had been made by the Board of Trade at the instance of a deputation from the Municipal Authorities with regard to the power to transfer Provisional Orders. In consequence of this letter the present meeting had been summoned; but in the absence of Mr. Hammond, the second matter on the agenda paper, viz., the proposed formation of a Labour Conciliation Committee, would be taken first.

The CHAIRMAN observed that the question of conciliation in labour disputes had occupied the attention of some of the most eminent members of the Chamber, and that the Section was now asked by the Council of the Chamber to consider whether they should have a Conciliation Committee.

Mr. GRAY observed that his personal opinion was that a Conciliation Committee was of no good, nor were offers of mediation from people who knew nothing whatever about the details of the case of any use.

Mr. MURRAY, the secretary, pointed out that the Conciliation Committee, according to the plan suggested by the Council, would consist of 12 representatives of the employers and 12 of the employed; they could meet privately at the offices of the Chamber, and if they failed to agree they might appeal to a Board of experts, on which both capital and labour would be equally represented; and, failing this, the dispute might be referred to arbitration.

Mr. GRAY replied that the spokesmen who were called representatives did not represent the majority of the employed; they were generally professional agitators.

The CHAIRMAN remarked that the question of real representation was important, and Mr. MURRAY said that they did not propose to deal with professional agitators, but with the representatives of the trades' unions.

Mr. GRAY mentioned names of certain so-called representatives of trades' unions who, in his opinion, were quite unreliable, but they would be bound to deal with them. Another difficulty arose in the working of the proposed plan. If the employed demanded 10 per cent. rise of wages and the employers submitted the question to the Board, the award would probably be a rise, though perhaps less than the full amount demanded. The employers should have an opportunity of stating their own views, that the Board might consider the proposition from each side.

Mr. ERSKINE inquired whether a firm coming to the Chamber with a labour dispute, and coming to no agreement, would be compelled to take the two other steps proposed, and go before the Board of Conciliation; to which Mr. MURRAY replied that nothing would be done unless both parties agreed.

Sir VINCENT BARRINGTON, Deputy Chairman of the Council, here entered the room, and said that the method of conciliation of the Chamber had acted very satisfactorily in the cases of the Medway and of the Oliver Wharf disputes.

Mr. TROTTER said the men were often unwillingly members of the trades' unions. They were persuaded to join while young, as soon as they were out of their apprenticeship, and after they had subscribed for seven years, they felt bound to the union on account of their money which they could not withdraw, and which became a tie sufficiently strong to compel them to act in opposition to their own sense of what was right.

The CHAIRMAN corroborated Mr. Trotter's remarks.

After further discussion, in which Mr. GRAY, Mr. MURRAY, and Sir VINCENT BARRINGTON took part, the latter observed that the men should send non-union representatives; in fact, if they were Irishmen, they should form a non-union union.

The CHAIRMAN then asked what the meeting wished to do. The matter was of great importance to the Section, whose members employed a very high class of labour and many different trades, and their works might be thrown on their beam ends by a dispute arising in a single trade.

Sir VINCENT BARRINGTON said that 45 committees had already been arranged, and that the employers could meet the representatives of the employed at the offices of the Chamber, with no one else in the room.

The CHAIRMAN proposed that a circular should be sent out with the view of forming a Conciliation Committee; and the motion was seconded and carried.

Mr. HAMMOND having arrived, and being called upon by the Chairman said that the Board of Trade had put the supply companies under obligations of not transferring their Provisional Orders, except by permission both of the Board of Trade and of Parliament; and the local authorities should, in his opinion, be under the same obligations. There was careful scrutiny of the applications of supply companies, but there was no such scrutiny for the local authorities. A local authority may apply for a Provisional Order with the object of passing it on to a private company, opposed, perhaps, of gasholders. After giving instances of such applications

Mr. ERSKINE asked whether the rules might not be made so stringent that an Order could not be used for obstruction.

The CHAIRMAN said he did not support a deputation to the Board of Trade, and thought that the only chance of getting the Model Order modified was in Parliament, and suggested that the supply companies who already had a *locus standi*, should be properly represented before Parliament by counsel.

A motion recommending this course was put and carried.

The CHAIRMAN then read a draft of a circular letter, which it was proposed to send to all supply companies both at home, on the Continent, and in America, asking them to co-operate in the mutual interchange of statistical information with regard to the cost of the production of electricity.

Prof. FORBES thought that the Section would get the information from most quarters, but he was doubtful whether they would get it from certain quarters, and if they did he would not believe it.

The motion that the letter be circulated being passed,

Mr. TROTTER reported that the replies of the railway companies to the objections raised by the Chamber on behalf of the Section to the proposed rates had been received, and he had referred them to Mr. Gale. The objections had in several cases elicited an interpretation by the railway companies of points in their classification, which resulted in the advance of the rates asked for by the Chamber; there were two concessions of lower rates, but there were still two or three articles for which the rates proposed by the companies were higher than seemed equitable, e.g., cables which the railway companies said were frequently coiled into and out of the waggons, increasing risk of damage; and steel castings, which were at a rate higher than iron castings. Wood mouldings were rated high as were included in an arrangement with the Master Builders' Association.

The meeting then dissolved.

Digitized by Google

THE ELECTRIC LIGHTING OF THE CITY.

A special meeting of the Commission of Sewers was convened last Tuesday at the Guildhall for the purpose of considering a report of the Streets Committee relative to the proposed contracts with the Brush Electrical Engineering Company, and the Laing, Wharton, and Down Construction Syndicate, for lighting portions of the City. Mr. Deputy Green presided.

The Streets Committee, while resisting certain proposed alterations in the draft contract, recommended the Commission to concur in the following, viz.:—"That the Company have way-leave in subways for private supply, notwithstanding the contract for public supply may have been determined. That the private supply be exclusive for 21 years, whether the contract for public supply be determined or not. That, as regards the remedy of defects found on inspection, the penalty be not enforced if the work of repair be commenced within twenty-four hours, and be proceeded with diligently to the satisfaction of the engineer. That, as regards the sliding scale, 7½ per cent. per annum be allowed for depreciation, and 5 per cent. per annum for a reserve fund, until such fund amounts to a quarter of the paid-up capital. That though the purchase of the undertaking for public supply at 21 years be under the Act, the purchase of the private supply at 21 years be by agreement or arbitration; the purchase of either at 42 years to be under the terms of the Act. Should your Honourable Court concur in our recommendations, we ask authority also to conclude, on similar terms, with the Laing, Wharton, and Down Construction Syndicate. With regard to the latter Company, we understand that the town of Taunton is lighted by their system, and suggest that we be authorised to send a deputation to inspect the same." (The following footnotes were appended:—"*i.e.*, 7½ per cent. on the capital sunk in the plant and machinery;" "*i.e.*, 5 per cent. on the paid-up capital.")

Mr. SLY reminded the Court that they rejected both the original suggestions of the Brush Company, and instructed their officers to draw up specifications for the lighting of the City. The Streets Committee divided the district into three sections—West, Central, and East. Two other companies proposed alterations in their specification, which the Court refused to agree to, and they accepted the offer of the Brush Company to light the Central district, because that Company adhered to the specification as the basis of an agreement. Afterwards the Court agreed to certain modifications, and now the Brush Company asked them to sanction further alterations. If they gave this Company the right of exclusive private supply for 21 years, whether the contract for public supply should be determined or not, they would not be studying the public interest, and they would be giving the Brush Company an advantage over the other two companies. The Brush Company first of all agreed to their proposals, and then, having got a certain hold upon them, they took up first one point and then another to their own advantage. He thought they might possibly get better terms under a Provisional Order. He moved that the matter be referred back to the Committee for reconsideration.

Mr. BRIDGMAN called attention to the footnote, and asked what the capital sunk in plant and machinery and the paid-up capital was likely to amount to.

Mr. CLOUDSLEY (Chairman of the Streets Committee) said they could not possibly tell. No doubt the Company would provide plant for the purpose as cheaply as possible.

Mr. BOWRING seconded the amendment. He thought to hand over the private lighting to any Company for 21 years would be a disastrous thing. They had to consider what might be the improvements in electric lighting during the next ten years.

Mr. A. A. WOOD was positively opposed to the private lighting clause, which he believed would be a gross injustice to the citizens. It was eminently advisable that they should, without delay, make a contract with some company for the supply of the electric light to the City, and he suggested that they should get rid of the word "exclusive." The Brush Company had shown great enterprise, and if they agreed to compete with other companies for the private supply of the City, the Commission would make a satisfactory bargain, and the consumers would get the electric light at a reasonable price.

Mr. BRIDGMAN said, besides the accumulated 10 per cent. allowed on the sliding scale there was now to be 7½ per cent. allowed for depreciation. The report said that this 7½ per cent. was capital sunk in plant and machinery. He assumed that the Company would require to call up at least £100,000 to carry out this work. They were entitled to have 5 per per cent. on that called up capital, which came to £5,000 a year.

Mr. PANNELL: The footnote is absolutely incorrect. It is not 5 per cent. on the paid-up capital.

Mr. CLOUDSLEY: It is a mistake.

The SOLICITOR (Mr. Baylis) afterwards explained that it was 5 per cent. on the profits available for dividend; and the report was altered accordingly.

The CHAIRMAN stated the history of the question, observing that it was most desirable that members should thoroughly understand the matter on which they were voting. Mr. Sly was wrong in saying that an absolute arrangement had been made with either of the companies. The Court had agreed upon a principle, and the solicitor had prepared a contract based on that principle. That was really as far as they had gone. It was the business of the Committee to try to tide over any difficulties which might arise. It was the public supply which they had in the first instance to direct their attention to; private users would to a large extent look after their own interests. The Company said they ought to have some consideration for wear and tear of plant and machinery, and this appeared to him a very reasonable proposal.

Mr. C. T. HARRIS described the action of the Brush Company as the most extraordinary repudiation of a deliberate agreement made with the Commission he had ever known. Were they to enter into a fresh contract which was not favourable to the Commission in one degree, but which was all in favour of the contracting Company? The proposed alterations were not on points of detail, but on points of principle. If they agreed to this they would only be able to continue the public lighting on the Brush Company's terms. They would have contracted themselves out of the Act which was designed for the benefit of consumers. The sliding scale was an entirely impracticable thing. Amongst the five companies applying to the Board of Trade for Provisional Orders were two very large and substantial companies, two of the largest in England—the London Electric Supply Corporation and the Metropolitan Electric Company.

Mr. PANNELL said the Commission considered that the two Companies referred to, notwithstanding the grand names attached to them, could not possibly be come to terms with. As far as he understood the question before the Board of Trade, it was this: If they could come to an arrangement with a company or companies for two of the districts, the Board of Trade would assist them; and, as far as they could, he took it these companies would get their agreement with them substantiated and approved by the Board of Trade. If they did not come to that agreement within a very limited period, he understood the Board of Trade would hand over all the applications now made for Provisional Orders to a Committee of the House of Commons, and they would have to go and oppose them there. He was informed on very good authority that this was the position. It did not very much matter, as long as they did not concede vital principles, what concessions they made, so long as these concessions were not more stringent than the applications for Provisional Orders. He did not think in the Provisional Order there was an arrangement for a sliding scale at all. Therefore, however trammelled their sliding scale might be, it was better than nothing. He understood it would take at least £300,000 outlay to cover the district they proposed to allot. If they desired to see the electric light introduced into the City of London they must do their best to compromise and meet the resources of these people who were going to find the money. He pointed out that a profit would actually have to be created by the Company before 5 per cent. could be set off.

Mr. Deputy SCOTT, Mr. SHAW, and Mr. DRESSER ROGERS having spoken, the amendment was negatived by 28 to 14 votes.

Mr. PELLETT moved to omit the word "exclusive," which was also defeated; and the report was agreed to.

On the motion of Mr. GRAHAM KING the deputation to Taunton was limited to ten members.

BOOKS, &c., RECEIVED.

"Electric Transmission of Energy." By Gisbert Kapp. Second Edition. (London: Whittaker and Co.)

"Electrical Influence Machines." By John Gray, B.Sc. (London: Whittaker and Co.)

"Almanach-Annuaire de l'Électricité et de l'Électrochimie. Année 1890." (Paris: Firmin Leclerc.)

"Guide Pratique de l'Amateur Électricien." By E. Keignart. (Paris: J. Michelet.)

"L'Éclairage Électrique Actuel." By Jules Couture. Second Edition, enlarged and revised. (Paris: J. Michelet.)

"Leçons sur l'Électricité." By Eric Gérard. Vol. I. (Paris: Gauthier-Villars et Fils.)

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-night) FRIDAY, March 28th.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "Foam." By the Right Hon. Lord RAYLEIGH, F.R.S.

INSTITUTION OF CIVIL ENGINEERS.

7:30 p.m. Students' Meeting. Paper to be read: "Deflection of Spiral Springs." By ALFRED E. YOUNG, Stud. Inst.C.E.

ELECTRO-HARMONIC SOCIETY.

8 p.m. Smoking Concert, St. James's Hall Restaurant.

SATURDAY, March 29th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture: "Electricity and Magnetism." By the Right Hon. Lord RAYLEIGH, F.R.S.

TUESDAY, April 1st.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary meeting. Paper to be read: "Barry Dock and Railways." By JOHN ROBINSON, M.Inst.C.E.

WEDNESDAY, April 2nd.

CIVIL AND MECHANICAL ENGINEERS' SOCIETY.

7 p.m. Paper to be read: "The General Doctrine of Oceanic Vertical Circulation." By W. LANT CARPENTER, B.Sc.

THURSDAY, April 3rd.

CHEMICAL SOCIETY.

8 p.m. Ordinary Meeting. "Note on the Hydrosulphides. By S. H. PICTON.

Digitized by Google

The Electrician.

Published every Friday. Price Fourpence; Post Free, Fourpence Halfpenny.
Editorial, Publishing and Printing Offices:
SALISBURY COURT, FLEET ST., LONDON, E.C.
Telephone No. 2714. Telegrams: "ELECTRICIAN NEWSPAPER, LONDON."

All Communications to be addressed to "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN."

All letters intended for insertion in "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. Subscribers should receive their copies by the first post on Friday morning.*

'THE ELECTRICIAN" *is on sale at the railway bookstalls throughout the United Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices as above.*

SPECIAL NOTICE.

Owing to the increase in the number of pages of "THE ELECTRICIAN," in order to partly cover the increased postage, we have been compelled to revise the rates for Foreign Subscriptions, which are now as follows:—

	3 months.	6 months.	12 months
For Foreign Parts and Colonies:—	s. d.	s. d.	s. d.
Within Postal Union	6 6	12 6	24 0
Aden, Borneo, Ceylon, China, India, Japan, Java Labuan Mozambique, New Caledonia, Persia, Philippine Islands, Siam, Transvaal, and Zanzibar	7 6	14 6	28 0
The rates for the United Kingdom remain as follows:—	5 0	10 0	19 6

TO ADVERTISERS.

"THE ELECTRICIAN" *offers exceptional advantages to Advertisers.* **It has the largest circulation of any English Electrical paper, and circulates all over the World.**

Particulars relating to Advertisements will be promptly forwarded on application to the office.

TRADE ADVERTISEMENTS *intended for the current issue must be handed in not later than First Post on Thursday morning.*

SMALL PREPAID ADVERTISEMENTS *(for Rates see page xv.) are accepted up to 4:30 p.m. on Thursday.*

TECHNICAL PRINTING.

'THE ELECTRICIAN" PRINTING AND PUBLISHING COMPANY (LIMITED) *beg to inform Electricians, Electric Light Engineers, &c., that they make a specialty of Technical Printing, and have a Staff thoroughly acquainted with Electro-Technology. They can, therefore, promise Accuracy and Despatch in the Printing of Electrical Catalogues and Electro-Technical Literature generally.*

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.

Royal 8vo, 5s., postage extra.

Early in each year is issued "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK. *The* DIRECTORY *was established in 1883, and the 1889 Edition consisted of more than 600 pages of printed matter. The names and addresses of all persons engaged in the Electrical Industries may be relied upon as accurate. Useful Tables and Electrical Formulæ, and information specially compiled for this work are given, together with popularly-written Biographical Notices of the leading Electricians, Electrical Engineers, &c., accompanied in many cases by Portraits.*

The issue for 1890, which is still further enlarged and improved (making 850 pages), is NOW READY. Orders should be forwarded at once to the Publishing Offices, Salisbury-court, Fleet-street, London, E.C.

CONTENTS OF THE CURRENT NUMBER.

NOTES 513
Magnetism in Iron and other Metals.—XI. By Prof. J. A. Ewing, F.R.S. Illustrated. Continued 518
Electro-Magnetic Radiation. By Prof. G. F. Fitzgerald, M.A., F.R.S. 519
Switchboard and Regulators of the St. James' and Pall Mall Electric Light Company. Illustrated 520
London Chamber of Commerce.—Meeting of the Electrical and Allied Trades' Section ... 522
The Electric Lighting of the City 523
Books Received 523
Meetings of Scientific Societies. 523
"TELEGRAPH CLERKS' GRIEVANCES." 524
OBITUARY—
Johann Georg Halske 526
The Institution of Electrical Engineers—
The Theory of Armature Reaction in Dynamos and Motors.—Some Points in Dynamo and Motor Design. *Discussion.* Illustrated ... 526
Barraclough's Wire-Covering Machine. Illustrated 530
The Engineers', Electricians', Builders', and Ironmongers' Exhibition 531
American Notes 531
Paris Notes 532
CORRESPONDENCE—
Dynamo and Motor Design. John Perry 532
Mapping the Waste Field of Dynamos.—Alexander P. Trotter 533
The Pfannkuche Alternator.—Gustave Pfannkuche ... 533
Fixing Magnetic Curves.—W. W. Haldane Gee 533
Legal Intelligence 533
Trade Notes and Notices 534
PATENT RECORD 534
COMPANIES' MEETINGS, &c.—
The Direct Spanish Telegraph Company (Limited) 534
The Telephone Company of Egypt (Limited) 536
Newcastle and District Electric Lighting Company (Ltd.) .. 536
New Companies Registered ... 537
City Notes, &c. 537
Companies' Share List 538

"THE ELECTRICAL WORLD" OF NEW YORK.

"THE ELECTRICAL WORLD" OF NEW YORK *can be obtained from* "THE ELECTRICIAN" *Office, Salisbury-court, Fleet-street, London, E.C. The Rate of Subscription (payable in advance), is* **£1 1s.** *per annum. Single Copies* **price 6d. each; post free, 8d.**

"THE ELECTROTECHNISCHE-ZEITSCHRIFT" OF BERLIN.

In future the above journal (with which has been incorporated "*The Centralblatt für Electrotechnik*") *will be issued weekly instead of fortnightly, the subscription being* **£1. 4s. 6d.** *per annum. Single Copies* **6d.; post free, 7½d.**

"THE ELECTRICIAN" PRINTING AND PUBLISHING COMPANY, Ltd., *are Agents in Great Britain for both the above well-known journals, and particulars as to Advertisements will be supplied on application to* "THE ELECTRICIAN" PRINTING AND PUBLISHING COMPANY, Ltd., *Salisbury Court, Fleet Street, E.C.*

GOOD FRIDAY.

In Good Friday Week "THE ELECTRICIAN" will be published on Thursday morning (April 3), instead of on Friday (April 4).

Contributors, Correspondents, and Advertisers are requested to take note, and to forward their communications as early as possible, but not later than Tuesday night in Good Friday week.

"TELEGRAPH CLERKS' GRIEVANCES."

Under this heading there appeared in *The Times* of the 4th inst. a manifesto of formidable dimensions, setting forth the grounds of dissatisfaction which for a long time past the public have been assured through Parliament and Press is widely prevalent among the *employés* of the Postal Telegraph Service. That service is a highly valuable one to the public, and the telegraphists are a very numerous body of public servants. The combination among them which is threatened in the document above referred to is, therefore, an event of considerable moment, and one which will attract a good deal of attention apart from the character of the grievances which the combination is designed to remedy. We had the POSTMASTER-GENERAL's assurance in Parliament last Friday that no hindrance or penalty would attach to telegraphists who united for purposes

Digitized by Google

ASPINALL'S ENAMEL

COPY OF LETTER JUST RECEIVED AT NEW CROSS.

A Leading and Well-known Electrician writes:—

"HAVING used your **ENAMEL** considerably for various purposes, I find that it has **GOOD INSULATING PROPERTIES FOR ELECTRICAL WORK**, answering the purpose better than the usual Insulating Compounds in use, *which do not give such an appearance or finish as your* **ENAMEL.**"

Sold everywhere, in Tins; or Post Free, 7d., 1s. 6d., and 3s.; for Baths, 9d., 1s. 9d., and 3s. 6d. from

Works: LONDON, S.E. REJECT WORTHLESS IMITATIONS.

AS AN INSULATOR.

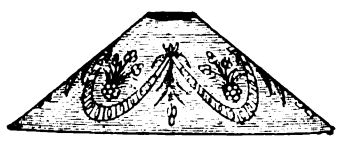
THE GENERAL ELECTRIC CO., Ltd. (G. BINSWANGER, Managing Director)

(OF LONDON AND MANCHESTER)

TELEGRAMS "ELECTRICITY." **71, Queen Victoria Street, LONDON, E.C.** [TELEPHONE No. 1887.

MANUFACTURERS AND SUPPLIERS OF ALL ELECTRIC LIGHT FITTINGS AND MATERIAL.

1,000 FANCY ELECTRIC SHADES.



6d. EACH.

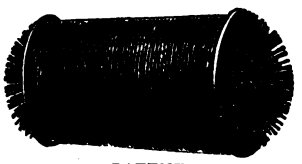
TO CLEAR STOCK ODD PATTERNS.

WE GUARANTEE THIS TRANSFORMER TO HAVE **A HIGHER EFFICIENCY** THAN **ANY CLOSED-CIRCUIT TRANSFORMER in the Market.**

NO HEAT. PERFECT INSULATION.

THE "HEDGEHOG" TRANSFORMER.

SWINBURNE'S



PATENT.

PRICES Include Terminals, Base, &c. Fireproof Cases Extra.

Lamps (30-w.)	H.-P.	Price. £. s. d.	Lamps.	H.-P.	Price. £. s. d.
*25	1	5 10 0	300	12	30 0 0
50	2	8 18 0	400	16	35 0 0
100	4	12 15 0	500	20	40 0 0
150	6	17 17 0	750	30	55 0 0
200	8	20 0 0	1000	40	85 0 0
250	10	24 0 0			

* We do not recommend this Size.

ANY SIZE TO ORDER.

SWINBURNE & CO.

ALTERNATING and CONTINUOUS CURRENT WATT-METERS, MOTORS, INSTRUMENTS.

PRIVATE HOUSE INSTALLATIONS.

IRON TESTED FOR THE TRADE.

BROOM HALL WORKS, TEDDINGTON, ENGLAND.

F. WIGGINS & SONS, Telephone No. 2248. } 10, Tower Hill, E., and 102, Minories, London, E.C.

Manufacturers of MICA GOODS for PHILOSOPHICAL and ALL PURPOSES.

CONTRACTORS TO HER MAJESTY'S GOVERNMENT.

MICA

ELECTRIC TRAM-CARS.

59,000 MILES ALREADY RUN.

Daily Average 300 Miles

(The Greatest Number of Miles ever run in this Country by ACCUMULATOR CARS),

Running on the **BARKING ROAD, E.,**

FOR THE

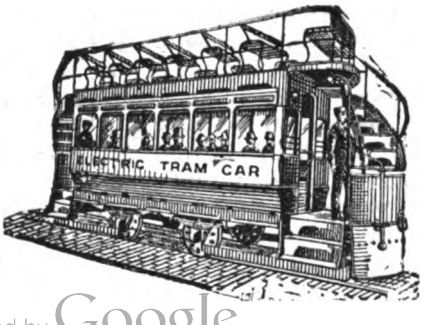
NORTH METROPOLITAN TRAMWAYS CO., LIMITED.

Everyone should see these Cars. Certain to supplant horse and every other form of traction.

Full particulars from the SECRETARY,

ELECTRIC TRACTION CO., Ltd.,

NEW BROAD STREET HOUSE, LONDON, E.C.



Digitized by Google

"THE ELECTRICIAN" INDEX TO ADVERTISERS.

Advertisers in "The Electrician" have their names inserted under the following headings in this Index FREE OF CHARGE.

ACCUMULATORS. PAGE.
Foreign and Colonial Electrical Power Storage Co., Ltd. 7
ACIDS.—Berk (F. W.) and Co. 23
ALTERNATORS.
Brush Electrical Eng. Co. (Ltd.). 21
Electrical Engineering Corpn. .. 538
Johnson and Phillips 1
Parsons (C. A.) & Co 12
AMMETERS.
Acme Electric Works ..... —
Goolden (W. T.) and Co..... 12
Moseley (W.)..... 3
Nalder Bros. and Co. ..... —
Sharp and Kent..... 4
ANTI-FOULING COMPOSITIONS.—Kirkaldy (J.) and Son. 7
ARC LAMP BLOCKS.
Joyner (Chas.) and Co. 6
ASBESTOS.
Bell's Asbestos Company.....28, 29
United Asbestos Company (Ltd.) —
ASBESTOLINE.
Bell's Asbestos Company 28, 29
AUCTIONEERS AND VALUERS (Mechanical).
Wheatley Kirk, Price and Goulty 3
B.A. SCREW THREAD.
Lehmann (Th) 19
BATTERIES.
Fowler, Lancaster and Co (Ltd.) 3
India Rubber & Gutta Percha Co. 16, 20
Johnson and Phillips 1
Laing, Wharton and Down 9, 19
Latimer Clark, Muirhead & Co. 1
BATTERY JARS.
Joseph Bourne and Son 19
Cannington, Shaw and Co..... 2
Price, Sons and Co. ..... —
Stiff (J.) and Sons ..... —
BELTING.
Balderston and Co. 21
Moseley (D.) and Sons..... 8
Thompson (N. G.)..... 6
Willcox (W. H.) and Co..... 20
CABLE COMPANIES.
African Direct Telegraph Co. .. 30
Anglo-American Telegraph Co. 33
Brazilian Submarine Tel. Co. .. 31
Direct United States Co..... 33
Eastern Telegraph Co..... 34
Eastern Extension Telegraph Co. 34
Eastern & South African Tel. Co. 30
Indo-European Co. 32
West African Telegraph Co..... 30
Western and Brazilian Tel. Co... 31
CABLE SUPPLIES.
Latimer Clark, Muirhead & Co... 1
Elliott Brothers 21
Felten and Guilleaume 1
Fowler-Waring Cables Co. (Ltd.) 8
W. T. Glover and Co. 19
W. T. Henley's Teleg. Works Co. 1
India Rubber & Gutta Percha Co. 16, 20
Johnson (R.) and Nephew 2
Johnson and Phillips 1
Pirelli and Co. ..... —
Telegraph Manufacturing Co. .. 6
M. Theiler and Sons 3
CARBONS.
Brush Electrical Eng. Co. (Ltd.).. 21
Chamberlain (H. and F.) 10
General Electric Co. 17
India Rubber & Gutta Percha Co. 16, 20
Johnson and Phillips 1
Laing, Wharton and Down 9, 19
Thompson (N. G.) (Carré) 6
Woodhouse & Rawson United, Ltd. —
CASINGS.—Acme Electric Works. —
Elliott, Samuel ..... —
Garrard (Robert) and Co. 20
McGaw and Co. 23
CONDUITS.—Johnson & Phillips 1
Fowler Waring Cables Co. 8
CUT-OUTS.
Acme Electric Works ..... —
Dorman and Smith 19
General Electric Co. 17
Laurence, Paris and Scott (Ltd) . 19
Wood (W.) and Co. ..... —
Woodhouse & Rawson United, Ltd. —
DISINFECTANTS.—Sanitas Co. 20
DYNAMO MANUFACTURERS.
Allen and Co. 24
Brush Electrical Eng. Co. (Ltd.).. 21
Latimer Clark, Muirhead & Co.. 1
Crompton and Co. (Limited).... 16
Cuttriss and Co. 10
Edison & Swan United Elec. Lt. Co. 5
Electrical Engineering Corpn. .. 538
Goolden (W. T.) and Co. 12
Gülcher Electric Lt. & Power Co. 23
W. T. Henley's Teleg. Works Co. 1
Holmes (J. H.) and Co. 4
M. Immisch..... —
India Rubber & Gutta Percha Co. 16, 20
Johnson and Phillips 1
Laing, Wharton and Down 9, 19
Laurence, Paris and Scott (Ltd.) 19
Oppermann (C.) 19
Parsons (C. A.) & Co..... 12
Paterson and Cooper 19
Sharp and Kent..... 4
Telegraph Manufacturing Co. .. 6
Thompson (N. G.).. 6
Western Electric Co. 24
DYNAMO BRUSHES.
F. H. Royce and Co..... 3
EBONITE & VULCANITE. PAGE.
Harburg India-Rubber Comb Co. —
D. Moseley and Sons 8
EDUCATIONAL.
School of Electrical Engineering —
ELECTRIC BELLS.
Acme Electric Works ..... —
General Electric Co. 17
India Rubber & Gutta Percha Co. 16, 20
Johnson and Phillips 1
King, Mendham and Co. 10
London Electric Wire Co. 19
Julius Sax 19
Telegraph Manufacturing Co. .. 6
Western Electric Co. 24
Woodhouse & Rawson United, Ltd. —
ELECTRIC CRANES.
Bolton (R.) and Co. 3
ELECTRIC LIGHT CONTRACTORS.
Bernstein Electric Lamp Co..... 19
Brush Electrical Eng. Co. (Ltd.).. 21
Latimer Clark, Muirhead & Co. 1
Crompton and Co. (Limited).... 16
Drake and Gorham..... 12
Edison & Swan United Elec. Lt. Co. 5
Electrical Engineering Corpn. .. 538
Foreign and Colonial Electrical Power Storage Co., Ltd. 7
Fowler, Lancaster and Co. (Ltd.) 3
Gülcher Elec. Light & Power Co. 23
W. T. Henley's Teleg. Works Co. 1
India Rubber & Gutta Percha Co. 16, 20
Johnson and Phillips 1
King, Mendham and Co. 10
Laing, Wharton and Down (Thomson-Houston) 9, 19
Parsons (C. A.) and Co. 12
Paterson and Cooper 19
Shippey Bros. (Limited)..... 27
Woodhouse & Rawson United, Ltd. —
ELECTRIC TRAM CARS.
Electric Traction Co., Ltd. 17
Electrical Engineering Corpn. .. 538
ENGINEERS & CONTRACTORS
Acme Electric Works ..... —
Bernstein Electric Lamp Co..... 19
Blenheim (W.) and Co. 6
Booth, Ellson and Co. 15
Brush Electrical Eng. Co. (Ltd.).. 21
Latimer Clark, Muirhead & Co. 1
Chamberlain and Hookham 7
Crompton and Co. (Limited).... 16
Drake and Gorham 12
Edison & Swan United Elec. Lt. Co. 5
Electrical Engineering Corpn. .. 538
Fowler, Lancaster and Co. (Ltd.) 3
Foreign and Colonial Electrical Power Storage Co., Ltd. 7
W. T. Henley's Teleg. Works Co. 1
Hulett and Co (Limited)..... 13
India Rubber & Gutta Percha Co. 16, 20
Johnson and Phillips 1
King, Mendham and Co. 10
Laing, Wharton and Down ... 9, 19
Laurence, Paris and Scott (Ltd.) 19
Nalder Bros. and Co. ..... —
Parsons (C. A.) and Co. 12
Paterson and Cooper 19
Julius Sax 19
Sharp and Kent 4
Shippey Bros. (Limited)..... 27
Starnes (J. S.) and Sons 22
Swinburne and Co. 17
M. Theiler and Sons 3
Thompson (N. G.)..... 6
Verity (B.) and Sons 10
Westinghouse Electric Company 2
Woodhouse & Rawson United, Ltd. —
ENGINE PACKING.
Bell's Asbestos Company 28, 29
Starnes (J. S.) and Sons 22
Willcox (W. H.) and Co..... 20
United Asbestos Company (Ltd.) —
ENGINES.
Bailey (W. H.) and Co. (Limited) 14
Brush Electrical Engineering Co. 21
Bumsted, F. D. ..... —
Crosaley Bros. (Gas) 26
Davey, Paxman and Co. 16
Hindley (E. S.) ..... —
Marshall, Sons and Co..... —
Parsons (C. A.) and Co. 12
Priestman Bros. (Limited) (Oil).. —
Ransomes, Sims and Jefferies .. 23
Richards and Co. ..... —
Robey and Co. 4
Willans and Robinson..... 14
EXPANSION SHEETING AND RINGS.—Bell's Asbestos Co.. 28, 29
United Asbestos Company (Ltd.) —
FITTINGS for ELECTRIC LIGHT
Crompton and Co. (Limited).... 16
Dorman and Smith 19
Electrical Accessories Company 2
Electrical Engineering Corpn. .. 538
Evered and Co. (Limited) ..... —
General Electric Co. 17
Gülcher Elec. Light & Power Co. 23
Hulett and Co. 13
Johnson and Phillips 1
Laing, Wharton and Down 9, 19
Ross, Courtney and Co. 10
Telegraph Manufacturing Co. .. 6
Verity (B.) and Sons 10
Western Electric Co. 24
Wolverhampton Electrical Co... 23
Woodhouse & Rawson United, Ltd. —
FIBRE.—Moseley (D.) and Sons .. 8
FUSES.
Electrical Engineering Corpn. .. 538
Fowler, Lancaster and Co. (Ltd.) 3
GALVANOMETERS.
Nalder Bros. and Co. ..... —
GLASSWARE.
Acme Electric Works ..... —
GAS LIGHTERS (ELECTRIC).
General Electric Co. 17
King, Mendham and Co. 10
Woodhouse & Rawson United, Ltd. —
GLOBES & SHADES
Dorman and Smith 19
Electrical Accessories Company 2
Fowler, Lancaster & Co (Ltd.) .. 3
General Electric Company..... 17
Hulett and Co. (Limited) 13
INDIA RUBBER.
Moseley (D.) and Sons 8
Pirelli and Co. ..... —
INSTRUMENTS.
Acme Electric Works ..... —
Latimer Clark, Muirhead & Co. 1
Crompton and Co. (Limited).... 16
Elliott Brothers 21
General Electric Co. 17
India Rubber & Gutta Percha Co. 16, 20
Johnson and Phillips 1
Moseley (W.)..... 3
Nalder Bros. and Co. ..... —
Paterson and Cooper..... 19
Sharp and Kent 4
Swinburne and Co. 17
Telegraph Manufacturing Co. .. 6
M. Theiler and Sons 3
Woodhouse & Rawson United, Ltd. —
INSULATION.
Aspinall's Enamel 17
Johnson and Phillips 1
INSULATORS.
Joseph Bourne and Son 19
Latimer Clark, Muirhead & Co. 1
Gerhardt (C. F.)..... 24
W. T. Henley's Teleg. Works Co. 1
India Rubber & Gutta Percha Co. 16, 20
Johnson and Phillips 1
Price, Sons and Co. ..... —
Stiff (J.) and Sons ..... —
Telegraph Manufacturing Co. .. 6
IRON ROOFS & BUILDINGS.
Fredk. Braby and Co. (Ltd.) 25
Francis Morton & Co..... 22
IVORY LABELS.
Endolithic Ivory Co..... —
JABLOCHKOFF'S DISTRIBUTION PATENT 538
LAMPS.
Bernstein Elec. Lamp Co. (Inc.).. 19
Brush Electrical Engineering Co. (Ltd.) (Arc and Incandescent). 21
Consolidated Telephone Construction & Maintenance Co, Ltd 11
Crompton and Co. (Limited).... 16
Dorman and Smith 19
Edison & Swan United Electric Light Co. (Incandescent) 5
Electrical Engineering Corpn. .. 538
Fowler, Lancaster and Co. (Ltd.) 3
Gülcher Electric Lt. & Power Co. 23
Holmes (J. H.) and Co..... 4
Johnson and Phillips (Arc) 1
Laing, Wharton & Down (Edison & Swan) 9, 19
Robertson (C. J.) 19
Sunbeam Lamp Co. 11
Western Electric Co. (Arc)..... 24
Woodhouse & Rawson United, Ltd. —
LIGHTNING CONDUCTORS.
Johnson and Phillips 1
Julius Sax 19
LUBRICANT.
Bell's Asbestos Company 28, 29
Willcox (W. H.) and Co..... 20
MANUFACTURING ELECTRICIANS.
Acme Electric Works ..... —
Latimer Clark, Muirhead & Co.. 1
Dorman and Smith 19
Drake and Gorham 12
Electrical Engineering Corpn. .. 538
Elliott Brothers 21
General Electric Co. 17
W. T. Henley's Teleg. Works Co. 1
India Rubber & Gutta Percha Co. 16, 20
Johnson and Phillips 1
King, Mendham and Co..... 10
Nalder Bros. and Co. ..... —
Parsons (C. A.) and Co. 12
Paterson and Cooper 19
Ross, Courtney and Co. 10
Julius Sax 19
Telegraph Manufacturing Co. .. 6
M. Theiler and Sons 3
Westinghouse Electric Company 2
Woodhouse & Rawson United, Ltd. —
MOTORS (ELECTRIC).
Brush Electrical Eng. Co. (Ltd.).. 21
Cuttriss and Co. 10
Electrical Engineering Corpn. .. 538
Goolden (W. T.) and Co..... 12
Gülcher Electric Lt. & Power Co. 23
Holmes (J. H.) and Co..... 4
M. Immisch..... —
Laurence, Paris and Scott (Ltd.). 19
Parsons (C. A.) and Co. 12
Shippey Brothers (Ltd.) 27
METERS (ELECTRICITY). PAGE.
Chamberlain and Hookham 7
MICA.—F. Wiggins and Sons .. 17
NON-CONDUCTING COMPOSITION.
Bell's Asbestos Company 28, 29
United Asbestos Co. ..... —
OIL CLEANER.
Woodhouse & Rawson United, Ltd. —
PAINT, &c.
Indestructible Paint Co 3
PATENT AGENTS —Berg (E.). 3
Chapman (J. C.) 22
PIPES (STONEWARE).
Scott and Co ..... —
PLATINA SCRAPS.
Jamieson (W. & J.) 3
PRINTING AND ENGRAVING.
Waterlow and Sons (Limited) .. 24
POROUS CELLS.
Joseph Bourne and Sons 19
Price, Sons and Co. .. .. —
Stiff and Sons ..... —
PULLEYS.—Richards and Co. .. —
SECOHMMETER.
Nalder Bros. and Co. ..... —
SHEET IRON.
Baldwin (E. P. and W.) 19
SOCKETS.—General Electric Co. . 17
SPEED INDICATORS.
Bailey (W. H.) and Co. (Limited) 14
Blamires (T. and H.)..... 3
SUPPLIES FOR CABLE SHIPS.
Lack (F.) and Sons 22
Starnes (J. S.) and Sons 22
Duncan Wallet and Co. 22
SWITCHES.
Acme Electric Works ..... —
Crompton and Co. (Limited).... 16
Dorman and Smith 19
Drake and Gorham 12
Edison & Swan United Elec. Lt. Co. 5
Fowler, Lancaster and Co. (Ltd.) 3
General Electric Co. 17
Holmes (J. H.) and Co..... 4
Sharp and Kent 4
Thompson (N. G.) 6
Verity (B.) and Sons..... 10
Wolverhampton Electrical Co... 23
Wood (W.) and Co. ..... —
Woodhouse & Rawson United, Ltd. —
TELEGRAPH ENGINEERS.
Acme Electric Works ..... —
Latimer Clark, Muirhead & Co.. 1
Elliott Bros. 21
W. T. Henley's Teleg. Works Co. 1
India Rubber & Gutta Percha Co. 16, 20
Johnson and Phillips 1
Telegraph Manufacturing Co. .. 6
Theiler (M.) and Sons 3
TELEGRAPH PAPERS.
Waterlow and Sons (Limited) .. 24
TELEPHONES.
Blenheim (W.) and Co 6
Consolidated Telephone Construction & Maintenance Co, Ltd. 11
Stanhope Company ..... —
Theiler (M.) and Sons 3
Universal Telephone Company .. 18
TOOLS.—Fenn and Co. ..... —
TRANSFORMERS.
Brush Electrical Engineering Co. 21
Electrical Engineering Corpn. .. 538
Gülcher Elec. Light & Power Co. 23
Johnson and Phillips 1
Sharp and Kent 4
Swinburne and Co. 17
TUBES, &c.—Spencer (John) .... —
TYPE-WRITING.
Richardson (W. J.) and Co..... —
VALVES.—Mosses and Mitchell .. 537
VENTILATING ENGINEERS.
Blackman Ventilating Company. 3
VOLTMETERS.
Acme Electric Works ..... —
Drake and Gorham 12
Edison & Swan United Electric Light Co. 5
Goolden (W. T.) and Co..... 12
Moseley (W.) 3
Nalder Bros. and Co. ..... —
Sharp and Kent 4
VULCANISED FIBRE.
Mosses and Mitchell..... 537
VULCANITE.
Harburg India-Rubber Comb Co. —
Moseley (D.) and Sons 8
WATCHES (NON-MAGNETIC).
Bedford (H. W.)..... —
WIRE (Covered or Uncovered).
Latimer Clark, Muirhead & Co.. 1
Felten and Guilleaume 1
Fowler-Waring Cables Co., Ltd. 8
W. T. Glover and Co. 19
W. T. Henley's Teleg. Works Co. 1
Johnson (R.) and Nephew 2
Johnson and Phillips 1
Laing, Wharton and Down 9, 19
London Electric Wire Co..... 19
Phillips Bros. 19
Phosphor Bronze Company 38
Telegraph Manufacturing Co. .. 6
Western Electric Co. 24
WIRE-COVERING MACHINES.
Barraclough and Co. 22
Johnson and Phillips 1
WOOD (*see* CASINGS).

Digitized by Google

"D&S." PATENT PORCELAIN ELECTRIC LIGHT FITTINGS.
ADOPTED BY THE PRINCIPAL Electric Light CONTRACTORS
SWITCHES, CUT-OUTS, LAMP HOLDERS & OTHER ACCESSORIES.
DORMAN & SMITH. Brazenose St. MANCHESTER.

E. P. & W. BALDWIN,

Works:—WILDEN, near STOURPORT.

MANUFACTURERS OF

PURE CHARCOAL SHEET IRON, SUITABLE FOR ELECTRICAL PURPOSES.

London Agents: BROOKER, DORE & CO., Corbet Court, LONDON, E.C.

INCANDESCENT LAMPS

FOR SHIPPING AND EXPORT.

LAMPS OF ALL VOLTAGES & CANDLE-POWERS
FITTED WITH ANY FITTINGS.

The Quality and Durability of these Lamps can be attested by Users and Customers during the past Three Years.

Prices.—For Lamps of between 5 and 25 c.-p., any Volts or Efficiency, including Fittings of any of the usual makes, Cases, Packing and **Free Delivery** in the United Kingdom and many other countries, from **1s. 11d.** to **2s. 6d.** each, according to quantity.

For further particulars and Samples address—

C. J. ROBERTSON,
100, ALDERSGATE STREET, LONDON, E.C

BRITISH ASSOCIATION STANDARD SCREW THREAD

TAPS, SCREW PLATES, DIES, GAUGES, &c. ($\frac{1}{4}$ to $\frac{1}{52}$ in.),

SUPPLIED BY **TH. LEHMANN,** Original Maker to G.P.O.

38, HAMPSHIRE STREET, TORRIANO AVENUE, LONDON, N.W.

OPPERMANN'S EXCELSIOR DYNAMOS,

OF HIGHEST POSSIBLE EFFICIENCY,

Are now made in Sizes to suit small Gas and Steam Engines from 5 Lights and upwards. Prices from **£6.**

The PLATING and DEPOSITING DYNAMOS

Have met with much Approval for nearly Ten Years, and are **More Used in London than any other Manufacturer's.**

Send for Prices and Testimonials to

CARL OPPERMANN, 41, SIGDON ROAD, HACKNEY, LONDON, N.E.

THE BERNSTEIN ELECTRIC LAMP CO., LTD

2, MARLBOROUGH MANSIONS
VICTORIA STREET, WESTMINSTER, S.W.

OWNERS OF THE

BERNSTEIN SYSTEM OF ELECTRIC LIGHTING.

The lamps of this Company are of low resistance, and entirely free from the claims of other companies.

ADDRESSES.

LAING, WHARTON, & DOWN, 82a, NEW BOND-STREET, LONDON, W., Electric Light Engineers & Contractors. Sole Operators for England of the Thomson-Houston system of Arc Lighting. Special Agents for the Edison-Swan Co.'s Incandescent Lamps and Apparatus. Manufacturers and Suppliers of every requisite for Arc or Incandescent Lighting, Dynamos, Lamps, Switches, Electroliers, Brackets, &c. Specialities in Primary Batteries for Electric Lighting. Venetian Shades and Glass, Carbons, &c. Temporary lighting on any scale at short notice. Estimates free. Telephone No. 3602.

JULIUS SAX, Electrical Engineer and Electric Light CONTRACTOR, RIDGMOUNT STREET, STORE STREET, LONDON, W.C.

Established 1855.

Specialities—Electric Bells, Burglar Alarms, Fire Alarms, Watchmen's Clocks and Fire Indicators combined, Water Gauges, Billiard Markers, Electric Vanes, Lightning Conductors, Speaking Tubes, Gas Lighters, Electrical Testing and Telegraph Instruments, Electrical Torpedo Apparatus.

Automatic Call Bells for Fire Stations, &c., fixed at all Stations under the control of the Metropolitan Board of Works.

Call Calls for Police Stations, Prisons, &c., as devised for and adopted by H.M. Home Office. Contractor to H.M. Post Office and War Office.

Electric Lighting—Domestic and Public. Estimates Free on Application. Eight Prize Medals awarded.

Telephone No. 3843. Telegraphic Address: "*Sax—London.*"

WALTER T. GLOVER & CO., Electric Wire and Cable Makers, SALFORD, MANCHESTER. Works: Bridgewater-street, Broughton-road, Salford; Salford Electric Wire Works, Salford; Springfield-lane Cable Works, Salford. Established 1868. London Address, 10, Hatton-garden, E.C.; Telegram, "Phonoscope," London; Telephone No. 6691. Manchester—Telegram, "Walter Glover," Salford; Telephone No. 1187.

Specialities—Glover's patent covered Gutta Percha Wire for Leading-in, Tunnel, and Underground Work. Specially covered Iron and Copper Wire for Aerial Lines. Fancy covered single and Double Copper Wire (Paraffined) for Telephonic and Bell purposes. All classes of Silk and Cotton covered Wires for Instruments and Dynamo Machines, Glover's Patent Electric Light Leads and Cables for the various systems.

All descriptions of Covered Wire and Cables for Telegraphic, Telephonic, and Electrical Work, as supplied to the Post Office and the principal Railways, Electric Light, and Telephone Companies.

LAURENCE, PARIS and SCOTT, Limited, Electrical ENGINEERS and CONTRACTORS, GOTHIC WORKS, KING-STREET, NORWICH. Dynamos, Motors, Automatic Cut-Outs, Back Current Cut-Outs, Excess Alarms, Multiple Switches, and Switch Boards. Complete Electric Lighting Plants. Central Station Plants. Estimates on Application.

PHILLIPS BROS., Electrical Wire Manufacturers, The Lea Telegraph Works, HACKNEY WICK, LONDON, E., late of Macintosh-lane, Homerton. Established 1870. Telephone No. 5422.

Specialities—Gutta Percha, India Rubber, Compound, Cotton, Silk, Flexible Cords, Telephone Wire, &c., &c. Multiple and other Wires. Special Wires for Dynamo Machines. Electric Light Leads, &c. Patent Non-Inflammable Insulation for Incandescent and Arc Lighting and Dynamo Machines.

THE LONDON ELECTRIC WIRE COMPANY, ANCHOR WORKS, PLAYHOUSE-YARD, GOLDEN-LANE, LONDON, E.C. (Late of Wenlock-buildings, Ironmonger-row, E.C.)

Specialities—Covered Wires of all descriptions for Electrical Instruments, Dynamo Machines, Bell and House Work, &c. Fancy Paraffined Wires specially prepared for Telephone and other indoor connections.

JOSEPH BOURNE and SON. Works: DENBY POTTERY, near DERBY. London: 6, ST. PANCRAS STATION. Manufacturers of the well-known Stoneware Telegraphic Insulators and Battery Jars. Brown Stoneware. White Stoneware. Brown Porcelain. Porous Cells. Economy, strength, durability, and perfect insulation combined. Prize Medal, Paris Electrical Exhibition.

Makers of Mr. Slater Lewis's Patent Self-Binding Insulator.

J. G. STATTER and CO., Limited, Engineers, ALLIANCE ENGINEERING WORKS, WEST DRAYTON. London Offices, Prince's Mansion, 68, Victoria-street, Westminster, S.W. Dynamos and Motors for all Purposes. Perfect Constant-Current System of Arc Lighting. Estimates free. Write for Lists.

PATERSON and COOPER, Electric Light and Power and Telephone Engineers. EUROPEAN WORKS, POWNALL ROAD, DALSTON (Near Haggerston Station). Contractors to H.M. Government, Leeds Corporation, &c.

Specialities—Phœnix Dynamos, Pilsen, Phœnix, and Clark-Bowman and J. F. Arc Lamps, Cardew's Voltmeter, Paterson's Electromagnet Am- and Voltmeter, Ayrton-Perry Am- and Voltmeters, Wallace Diamond Carbons, Switches, Safety Junctions, and Fittings for Arc and Incandescent Lighting. (Removed from 76, Little Britain, since Nov. 16, 1885).

Digitized by Google

THE
INDIA RUBBER, GUTTA PERCHA, & TELEGRAPH WORKS
COMPANY, LIMITED.

Offices: 106, CANNON STREET, LONDON, E.C.

MANUFACTURERS OF
DYNAMO MACHINES,
INSULATED ELECTRIC LIGHT WIRES AND CABLES,
Lamp Fittings, Switches and Testing Apparatus, Volt and Ampere Meters.
CONTRACTORS FOR THE SUPPLY AND FITTING UP OF
ELECTRIC LIGHT APPARATUS
OF EVERY DESCRIPTION.
INSTALLATIONS FOR CENTRAL STATIONS, SHIPS, HOUSES, OR FACTORIES.
ESTIMATES ON APPLICATION.
Works: SILVERTOWN, LONDON, E.
[See detailed advertisement facing "Notes."

W. H. WILLCOX & CO.,
ENGINEERS' STORES FOR ELECTRIC LIGHT COMPANIES.
36, SOUTHWARK STREET, LONDON, S.E.
Works: EWER STREET. Telephone No. 4740 Telegraphic Address: WILLCOX, SOUTHWARK STREET, LONDON.

Stores:
ENGINE PACKING,
LEATHER BELTING,
LUBRICATING OILS
— OF —
EVERY DESCRIPTION,
CYLINDER OIL,
DYNAMO OIL.

Stores:
SPONGE CLOTHS & COTTON WASTE,
SIGHT FEED LUBRICATORS,
STEAM FITTINGS,
COTTON, HAIR, AND INDIA-RUBBER BELTING.

MAHOGANY, HARDWOODS AND TIMBER.
Telegraphic Address: "ACAJOU LONDON.
ROBERT GARRARD & CO.,
206, BETHNAL GREEN ROAD, LONDON, E.
THOROUGHLY SEASONED
MAHOGANY, TEAK, WALNUT, OAK, &c., &c. DRY PINE, PITCH PINE and DEALS.
CABLE CASINGS AND COVERS IN ALL WOODS AND DESIGNS.
Seasoned Woods Cut to Sizes for Telephone Boxes, Electric Apparatus, &c.
LOGS.—MAHOGANY, TEAK, WALNUT AND OTHER LOG TIMBER, IN TIERS OR SINGLE LOGS. SPECIFICATIONS ON APPLICATION.

TRADE "SANITAS" MARK.
DISINFECTANTS
(FLUIDS, POWDER, SOAPS),
NON-POISONOUS, PLEASANT AND BEST.
Used by more than 1,000 Boards of Health and Hospitals.
Gold Medals, Calcutta 1883-4, Paris 1885, Antwerp 1886.
For use at the Home and Foreign Stations of Telegraph Companies and on Board Ship
"Valuable Antiseptic and Disinfectant.—*Times.*"
"Safe, pleasant, and useful."—*Lancet.*
The "Sanitas" Company, Limited,
LETCHFORD'S BUILDINGS, BETHNAL GREEN, LONDON.

Digitized by Google

of this sort, so long as they did not presume upon their position to commit breaches of discipline which could not be tolerated in other people. Mr. RAIKES has displayed a similar leniency towards postal *employés*, who have been allowed to assemble and discuss their grievances in a manner not permitted by any of his predecessors. It may, therefore, be assumed that this movement among the telegraphists will go forward unimpeded by the officials; and that, if there is any real strength in it, there will be created a proportionate amount of pressure to enforce its demands. We say "enforce," for it is hard to see what object "an association with offices, and half-a-dozen sub-committees actively engaged," can have, unless to extort by threats what would not be yielded to argument.

Now, the public have lately been made only too familiar with associations of that kind; and whatever else may be said of them, one thing has been perfectly clear throughout all the recent strikes, namely, that the public take no account of the causes of dispute, but concern themselves with the consequences only. Probably on this fact their representative committees have presumed in drawing up the "Telegraph Clerks' Grievances." We never saw a manifesto so long containing so little. Approaching it with a predisposition to sympathise with any reasonable claims put forward by a highly intelligent and fairly well-educated body of men, we have left its perusal with feelings of an exactly opposite kind. We still retain too high an opinion of the telegraphists to believe that this document is a fair expression of their views, or a correct sample of the way in which they would be put if the men were left to themselves. The fact seems to be, that in all movements of this kind, when once their interests are handed over to a separate and practically irresponsible coterie, whose business it is to create or magnify grievances, the original complainants disappear from the scene altogether And the case of the telegraphist is apparently no exception to the rule; for both in this manifesto, and in the questions subsequently put into the mouths of Members of Parliament, there is abundance of evidence that the moving spirits either do not really understand the matter with which they are dealing, or are so inconsequential in their reasoning as not to perceive the contradictory nature of their own actions.

For example, one of their foremost grievances is that superior appointments are not open to telegraphists. Not many nights after this was printed the POSTMASTER-GENERAL was taxed with having selected certain telegraphists for superior appointments "over the heads" of their seniors. The selections, as it turned out, were on account of superior fitness. Do the memorialists suppose that advancement to those positions of postmasters and surveyors' clerks, which are so much coveted, can be made on any other grounds? Again, while complaining of stagnation of promotion, they deprecate the fact that a great number of the men at the Central Office, possessing equal qualifications and equal length of service, are in receipt of widely different pay. We know nothing as to the facts; but it is obvious that without some such inequality promotion would indeed be stagnant, for there would be nothing to promote to. In the same way "classification" is objected to; but without classification, promotion, instead of being, as it is, generally by fixed stages and according to seniority, would be ruled by selection solely, as in most private businesses, where "passing over" is common. In point of fact, directly the meaning of this much-derided "classification" becomes generally known, the more will the telegraphists be envied rather than pitied. There is only one conceivable explanation of their complaints on this point, namely, that they not only want to be at the top of their own class, but will never be content till they all get to the top of the classes above them. Apparently they are everyone fit for superior appointments, and everyone must have them, or the POSTMASTER-GENERAL shall know the reason why. Pushed to its logical outcome, almost every paragraph in the manifesto would bear the interpretation, briefly, that we are all equal, and are all equally entitled to be highly paid. The premises and conclusion both are absurd; but, unfortunately, there is no absurdity of which a trades' combination committee cannot be guilty.

Examining the manifesto as a statement of facts, we are again met by the same disregard of the most elementary precautions indispensable to the success of any appeal to a Government department. It is alleged among other questionable things that the telegraphists "never accepted" Mr. FAWCETT'S scheme. If our recollection is not greatly at fault, they profited by it considerably; and to say that they did not accept it in the sense of having rejected it is simply untrue. Further, they complain of "deduction of pay during sickness." The public will naturally think this a grievance; but when they come to see what the deduction really is, they may probably think, as we do, that this language is rather calculated to mislead. The same remark applies to the hours of duty. Telegraphists have already obtained that ideal working-day of the British artisan—with the meal times, we believe, thrown in. We learn from this memorial also that telegraphists are paid overtime *pro ratâ* on their salaries, and that somehow or other they consider this a grievance, asking in the same breath to have their hours of work reduced to seven as in some other Government departments, where, in fact, the *pro ratâ* system is unknown. These telegraphists prefer to designate themselves Government clerks—and we rather commend them for it; but in what other public department do Government clerks get paid overtime at the same rate as their salaries? There may be exceptions; but we have always supposed that the much-talked-of 10d. an hour was the rule. The telegraph clerks' modest demand is for a rate and a quarter for overtime—that is to say, wages of 48s. a week shall entitle the recipient to 1s. 3d. per hour overtime. There is only one thing to be said for such a contention—that it would tend to do away with overtime entirely; and if what they assert with reference to the mental and bodily strain of their normal duties be true, the sooner they are relieved from the additional work (and its remuneration) the better it will be for the Telegraph clerks. But here again we hesitate to accept statements which if literally true would go to prove that telegraphy is one of the most exacting and exhausting occupations known to us. If medical testimony will bear this out, there is no need for associations and sub-committees to obtain redress for one, at least, of the telegraph clerks' grievances. As for the rest they are summed up in the phrase "reasonable pay." We do not pretend to know what is reasonable pay for a telegraphist; but for the discussion of every such question on a satisfactory footing there must be reasonable people on both sides; and from the amount of unreason embodied in the manifesto now put before the public on behalf of the telegraph clerks, we are persuaded that reasonableness is not conspicuous in that quarter. We should be the last to deter them from trying by every legitimate means to obtain a better scale of pay if they can justly claim it; but we would point out to them that in this, as in all other callings, there is a limit beyond which it is impossible for the rank and file to rise, and that the reasonable course to adopt is to keep expenditure well within that limitation, neither forestalling nor counting upon those rare promotions to higher grades which must necessarily fall only to the exceptionally fortunate or the exceptionally gifted few. Men as a rule are *not* equal, and telegraphy tends rather to develope the higher qualities where there happen to be any.

Digitized by Google

OBITUARY.

JOHANN GEORG HALSKE.

The death is recorded, at Berlin, of Herr Johann Georg Halske, the co-founder and, for many years, partner of the well-known firm of Siemens and Halske. He was born at Hamburg on July 30, 1814, and went to Berlin, where he set up an engineers' shop, in 1844. Soon after he made the acquaintance of Werner Siemens, and it was in Halske's workshop that Werner Siemens, assisted by the mechanical skill of the former, was able to work out his first inventions in telegraphy so as to bring them before the public. In 1847 the two men entered into partnership, and laid the foundation of the electrical works which at the present day give employment to thousands of workmen both at Berlin and Charlottenburg, and at several branch establishments. Herr Halske left the firm in 1867, and since then has been an active member of the municipality of Berlin.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

THE THEORY OF ARMATURE REACTION IN DYNAMOS AND MOTORS.

SOME POINTS IN DYNAMO AND MOTOR DESIGN.

DISCUSSION. (Authorised Abstract.)

February 27th.

Before the commencement of the discussion proper, Mr. ESSON made a few remarks on the construction of the armature cores in the machines used as dynamos and motors, the results of which are given on slip 19 (*The Electrician*, March 21, p. 495). The Gramme and Pacinotti, he said, were built up of thin discs, whilst the Bürgin had wire cores carried by six-armed spiders. He thought the great difference between the E.M.F. of the latter when used as dynamos and motor might be due to the iron wires having been brought into electric contact by forcing the spiders in the rings and thus causing parasitic currents. He also corrected an error made in stating Mr. Ravenshaw's rule on slip 13 (*The Electrician*, March 14th, p. 475), where instead of the ampere-turns being 24 and 48 times the area of the field-magnets, 35 and 70 times the area of the armature core should be substituted. With reference to this rule, Mr. Esson said, if it was true, then by doubling the length of an armature the load might be doubled without giving rise to sparking. In his opinion the ampere-turns should remain the same. Again, Mr. Ravenshaw's rule would, when applied to similar machines, give the ampere-turns on armature proportional to the square of the radial depth of core, whereas on slip 12 (*The Electrician*, March 14th, p. 475), this was shown to be proportional to the first power of the depth.

Prof. AYRTON said he was particularly interested in Mr. ESSON'S Paper because it contained so many experimental results. Referring to Mr. Swinburne's method of treating the subject, he deprecated the use of the term "magnetic potential" where "difference of magnetic potential" was meant. He also thought Mr. Esson's term "working saturation," slip 3, § 4 (*The Electrician*, March 7th, p. 451) was not to be recommended, and that "working induction" would be much better. In his further remarks the Professor said he would confine himself chiefly to three heads, which were brought out prominently in a Paper on "Electromotors," by Prof. Perry and himself in 1883 (*The Electrician*, August 11, 1883, *et seq.*), and about which considerable difference of opinion still existed. These were—1st, the existence of magnetic lag; 2nd, the alteration of resistance of revolving armatures by self-induction; and 3rd, motor construction for minimum weight. As regards magnetic lag, this, he said, had often been denied; but quite recently Prof. Ewing had shown that such lag did occur, amounting in some cases to several minutes. With reference to the increase of resistance of revolving armatures due to self-induction, he thought some misunderstanding existed; for Mr. Swinburne in his Paper says that "power cannot be lost by self-induction." In their original Paper Prof. Perry and himself had given a formula for calculating this loss when the brushes were placed at the neutral position, and this they confirmed experimentally. When, however, this condition is not fulfilled a modification is necessary. If the brushes could be placed at an absolutely non-sparking position the resistance of the armature would not be increased by rotation, for then a section leaves the brush and is thrown into circuit with the proper current in it, and hence no further E.M.F. is needed to bring the current up to its proper value. In fact, the energy used in starting the current is supplied by the belt whilst the coil is short-circuited. He also said that in a dynamo with sparkless lead, the coils between the neutral lines and the brushes acted as motor coils and assisted the rotation of the armature, whereas in a motor they act as dynamo coils and oppose the rotation. Before passing to the third heading, reference was made to some remarks of Mr. Esson in the discussion on Mr. A. T. Snell's Paper of "Design of Motors," read before the City Guilds Old Students' Association last year. Mr. Esson then said that the chief use of the series winding in compounded Manchester dynamos was to counteract the demagnetising action of the armature. To test this, experiments had been made on such a machine, and it was found that out of 10,560 ampere-turns required at full load, 2,660 were required to compensate for back induction, and 2,100 for loss due to resistance of armature. Commenting on "The Best Relation of Iron to Copper in Armatures" (slip 17) (*The Electrician*, March 21, p. 494), Prof. Ayrton thought it a mistake to assume constant induction in the armature, for an increase of copper would mean greater excitation. Taking the excitation as fixed, Prof. Perry and himself had shown (*Proc.* Phys. Soc., Vol. IX., p. 220) that maximum output was obtained when the magnetic resistance of the space occupied by copper was equal to that of the rest of the circuit. As regards the question whether motors should or should not be made different from dynamos, the speaker said that in an Immisch series motor run as a dynamo and as motor at the same speed and current, the E.M.F. (neglecting self-induction) was 14 per cent. greater as a motor, and when the maximum possible effect of self-induction was allowed, a difference of 10 per cent. still remained. This had since been confirmed by measuring the induction in the field-magnets, both when a current was sent through the magnet coils alone, and then through both magnets and armature, the latter revolving at 1,400 revolutions as a motor. In the latter case the induction was 5 per cent. greater than in the former. Experiments on the characteristics of a magneto Gramme used as a generator and as a motor with equal lead and trail, show that as a dynamo the curve falls as in Fig. 15 (*The Electrician*, March 7, p. 451) of Mr. Esson's Paper; whereas, as a motor, the curve rises with increase of current. On trying the same experiments with a separately excited A Gramme, the E.M.F. as a motor always increases with the current through the armature, whatever the strength of exciting current used; but as a generator the E.M.F. always decreased, and, with a weak field, became negative when the armature current increased. In conclusion, Prof. Ayrton contended that the above experiments, as well as those of Mr. Esson on the Bürgin machine, proved conclusively that a relatively powerful armature strengthens the field of a motor and weakens that of a dynamo.

Mr. RAVENSHAW said that, apart from their own merits, Mr. Swinburne's and Mr. Esson's Papers would be most useful in promoting discussion on the causes of sparking. As regards Mr. Esson's expression for the ampere-turns which may be carried on an armature, he could not say that it held good in practice. He himself had experimented a good deal on the subject, and the results seemed to point to the fact that, for all sizes and shapes of well-designed machines, their behaviour at the brushes would be very similar when the ratio between the ampere-turns and the total induction in the armature was the same. This he gave not as a law, but as a result of his own experience. This experience, however, did not agree with that of Mr. Esson. One machine made for 4,000 watts, on which he had made many experiments, had a very small distance between the pole-pieces and armature core, and the pole-pieces were rather close together. After testing it under these conditions up to 6,000 or 7,000 watts, he tried it with the field bored much larger, and also with the poles cut off until they embraced an angle of 90deg. Under all these conditions the maximum ampere-turns it would carry without sparking appeared to be the same, the armature induction being kept constant. This machine was afterwards wound with a drum armature, and he had built two other types of machines with the same area of armature core, both of which carried the same ampere-turns. The above table shows Mr. Esson's coefficient for these three machines. According to Mr. Esson, No. 4 should have carried double the ampere-turns on No. 6, but as a matter of fact No. 6 sparked decidedly the least. No. 8 was built when copper was very expensive, and was in all *other* respects the same as No. 7, excepting that it had a large armature, large polar surface, and a very short air-space. Both machines were sparkless, but began to spark at about 50 per cent. above full load. Nos. 1, 2, and 3, were of entirely different design, agreeing only in the area of armature core. They all behaved in exactly the same way at the brushes when working with the same number of ampere turns on the armature. All the eight machines sparked a good deal with 50 per cent. more load than that given in the table. Mr. Esson had said that if the length of the armature were increased, the ampere turns must be kept constant. In reply to this Mr. Ravenshaw said he built all his machines in sets of three, the only difference between the largest and the smallest of each set being in the length of the armature and magnet cores, and the ampere-turns on the armature were increased in the same proportion. In Gramme armatures the output was limited by sparking, but with drums it was limited by heating, for the ampere-turns which could be carried by the latter were at least double those of the former. Speaking of magnetic leakage, Mr. Ravenshaw said most engineers seemed to think it impossible to calculate it with certainty; but this was erroneous, for he had been in the habit of calculating the leakage from the drawings for some years past, and always obtained accurate results. This was important, as he found that the leakage may be as high as 45 per cent., and as low as 20 per cent.

	Dynamo.	Kilowatts.	Mr. Esson's coefficient.	Ampere-turns. Armature core area.	Armature.
1	4-pole	16	40,000	31	Gramme
2	Under type	16	50,000	32·5	Gramme
3	Gramme field	16	70,000	28·5	Gramme
4	Under type	6·5	36,000	72	Drum
5	Over type	6·5	62,000	67	Drum
6	Over type	6·5	73,000	64	Drum
7	Over type	46	151,000	61	Drum
8	Over type	46	220,000	60	Drum

Digitized by Google

Mr. KAPP stated that the two Papers under discussion would form very important landmarks in the development of the dynamo, and said the subjects treated in them had been brought into prominence by the use of large machines. According to Mr. Swinburne, the limiting diameter of armatures in two-pole machines was about 40 centimetres, but he (Mr. Kapp) had, by increasing the dimensions of all the parts proportionately, made dynamos with 50 cm. armatures, and others had gone still higher. Referring to formula 2 in Mr. Swinburne's Paper (*The Electrician*, February 14th, p. 374), he asked whether the coefficient M was correct, for, as given, the length of the armature was not taken into account. His own experience gave coefficients varying from 0·12 to 0·18, instead of from 0·08 to 0·085. He also found that the magnetic leakage resistance in English measure for two-pole dynamos of the upright type was expressed by the formula $\frac{680}{\sqrt{ld}}$, and for the inverted type by $\frac{460}{\sqrt{ld}}$, where l and d are the length and diameter of the armature in inches. As regards reversing pole-pieces, he said that they were brought out about about five years ago by Mather. Coming to Mr. Esson's Paper, Mr. Kapp wished to add one device for equalising the field in single-magnet machines, which had been omitted from the interesting collection on slips 4 and 5. This device consists in making the upper horns *b*, Fig. 7 (*The Electrician*, February 28th, p. 425), rather longer than the lower ones. As regards the ratio of armature to field section dealt with on slips 6 and 7 (*The Electrician*, March 7th), he thought the remarks there made were only applicable to badly designed machines, for in good dynamos there was no room for such radical changes. The agreement of Mr. Esson's coefficients in Table II. (*The Electrician*, March 14th, p. 475), he said, was rather surprising at first sight, but on examining the formula it may be seen to be equivalent to saying that the maximum ampere-turns on an armature may be proportional to the ampere-turns on the field-magnet required to produce a given induction in the armature—a not unnatural conclusion. His own opinion was that both Mr. Esson and Mr. Ravenshaw loaded their machines too heavily. As a rough rule he found that the expression ampere-turns on armature $=1{,}000\ (d-5)$, where d is the diameter in inches, agreed very well with his practice. He cordially endorsed Mr. Esson's remarks on the small rise of temperature allowed by the Admiralty, for a rise of 11° C. meant enormous machines for their output. On the other hand, he usually allowed more cooling surface than Mr. Esson, his rule being 1·5 and 2·5 square inches per watt wasted in armature and magnets respectively. Referring to the relation between size and output, Mr. Kapp thought the exponent 2½ given by Mr. Esson was rather low; for, from actual tests on machines with armatures varying from 7in. to 13in. in diameter, he found that for Gramme-winding the output varied from d^{3} to $d^{3\cdot7}$, and for drums from $d^{3\cdot3}$ to $d^{3\cdot9}$.

Mr. FARQUHARSON said he thought the Admiralty rule for limiting rise of temperature had been misunderstood, and in Mr. Esson's Paper it was wrongly stated, for the rise permitted was 30° F. and not 11° C. The method of testing adopted by the Admiralty was to take the temperature outside the insulation immediately the machine was stopped. This temperature was by no means the same as that within the conductor, for he had known the outside temperature to rise for 20 minutes after the machine was topped.

Keeping this fact in view, together with the long continuous runs (sometimes amounting to 24 days and nights) to which ship-lighting dynamos may be subjected, he thought the Admiralty were justified in fixing the limiting temperature low enough to be safe for all machines. As a proof that the rule was not impracticable, he mentioned that all of 12 machines already delivered this year were well within the limit allowed.

Mr. A. T. SNELL, speaking of machines run as dynamos and as motors, said he always found it possible to get a greater output at a given speed when running as a motor, and that the trail as a motor was always less than the lead as a dynamo. In fact, with motors used for tramcars they worked without lead, and run in either direction with the same pair of brushes. Another point in which motors differed from dynamos was the possibility of using very thick brushes with advantage in the former, whereas in the latter such a proceeding proved disastrous. These differences seemed to him to show that the magnetic distributions in generators and motors are not the same, and that in dynamos the field was more straggling and subject to greater distortion. Referring to Mr. Esson's formula for the loading of armatures Mr. Snell said he had tested it on machines with which he was acquainted, and although he found a certain agreement, this was by no means so close as the numbers given in the Paper. He had himself been in the habit of using the formula

$$\text{Electrical horse-power} = l\ d^2\ n\ \text{K},$$

where l and d are the length and diameter of the armature, n the speed, and K a constant; and this gave close approximations where the armatures have the same proportions (*The Electrician*, March 14, p. 463). Alluding to rise of temperature in large machines after long runs, he mentioned that in some machines designed to work between 50 and 100 horse-power this amounted to 50 deg. Fahr., the temperature being taken on the wire on the inside of the cylinder armatures.

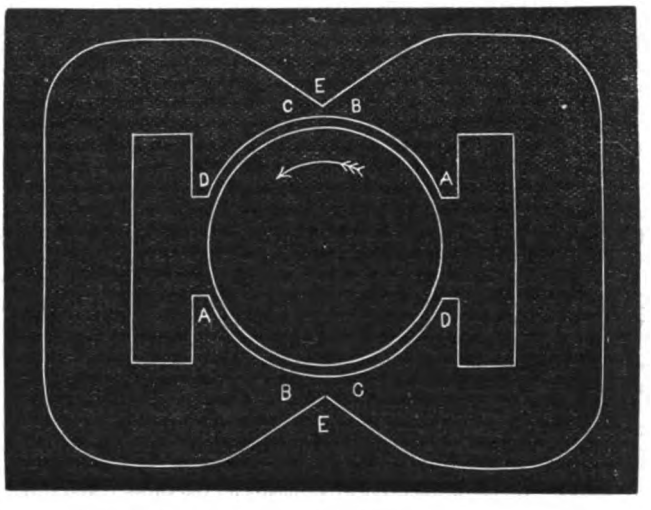
The discussion was then adjourned to March 13th.

March 13.

Prof. AYRTON exhibited curves, representing results of experiments on the Gramme magneto and Gramme dynamo when run as motors and generators, which he described on February 27th. Another curve showed similar results obtained with a Manchester dynamo separately excited with half its normal current. In this machine, run as a generator with a lead of 11deg., the E.M.F. decreases with increase of current in the armature, whereas when run as a motor, with a trail of 11 deg., the E.M.F. rises under the same conditions. From these observations he concluded that Mr. Swinburne and Mr. Esson were wrong in saying that the back E.M.F. in a motor could not be greater than the forward E.M.F. in a dynamo working under the same conditions as to speed and current. The secret of obtaining this increased E.M.F. in motors was, he believed, the employment of a relatively powerful armature.

Mr. WILLANS, referring to Mr. Esson's remarks on slip 4 (*The Electrician*, February 28th, p. 425), relating to the magnetic pull on armatures of single-magnet machines, said the inverted type there described (Fig. 5) was the worst that could be adopted; for, by employing those of the upright type (Fig. 4), the magnetic pull could be caused to support the weight of the armature, and the supposed defect converted into a distinct advantage. Speaking of the Admiralty temperature limit criticised by Mr. Esson and Mr. Kapp, he said that in testing the combined efficiency of engines and direct-driven dynamos, they had, with machines that run cool, obtained 84 or 85 per cent. of the indicated horse-power available at the dynamo terminals. On the other hand, machines that get hot never yielded more than 70 per cent. Whilst agreeing with the Admiralty that the rise of temperature allowable should be small, he objected to the method of taking the temperature; this method he characterised as being more a test of the heat conductivity of the insulation and the thermometer than of the temperature of the machine.

Prof. FORBES said both authors had touched upon very important points which had not been previously discussed in public. As regards Mr. Swinburne's Paper, he said non-mathematical readers should not accept unreservedly all the conclusions there arrived at, for some of them are admittedly based on approximations and assumptions which are not always fulfilled in practice. Nevertheless, he considered the treatment a step in the right direction. He could not accept Mr. Swinburne's statement that self-induction *prevents* waste of power, for all sparking is due to self-induction, and consequently it *causes* a waste of power. Another point about which he had grave doubts was the efficiency of the method of throttling cross-induction shown in Figs. 3 and 4 (*The Electrician*, February 14, p. 375).



His own (Prof. Forbes') opinion was, that such methods would tend to concentrate the lines about B and D (*see* Figure), whilst the field at A and C would be relatively weak. He also thought that, by partly filling up the space at E, a greater induction through the armature would be obtained. Referring to reversing pole-pieces, described on slips 8 and 9 (*The Electrician*, February 21, p. 400), he thought them ingenious, but open to considerable objection, and believed other and better means of preventing sparking would be devised. Coming to Mr. Esson's Paper, he said the remarks on slip 2 (*The Electrician*, February 28th, p. 424) respecting the utility and accuracy of calculating the waste field were directly opposed to his own opinion on the subject, and also to the experience of Mr. Ravenshaw. This point he thought gave a good instance of how some self-designated "practical men" object to spend the few hours necessary to calculate the waste field, and prefer spending a month's labour in making a machine, with all its attendant expense, in order to obtain experimentally results which could have been readily derived by calculation. He congratulated Mr. Esson on the many experimental results given in his Paper, and on the valuable and interesting way in which he had treated the subject of loss by hysteresis, illustrated by Fig. 14 (*The Electrician*, March 7th, p. 450), and the distortion of the field produced by the armature current. His own experience with non commutating dynamos had brought the latter phenomenon prominently before him, for he had found the E.M.F. at full load to be about half its value at no load. This he attributed to the fact that a given demagnetising force produces a much greater change of induction than that produced by an equal magnetising force when the iron is not saturated. Referring to the loads carried by armatures, slip 10 (*The Electrician*, March 14th, p. 475), he considered that the limit should not be fixed by sparking, but rather by questions of heating and efficiency. Armatures designed on the latter line should then be examined by the light of Mr. Esson's formula, and if they do not satisfy, the non-sparking condition must be modified accordingly.

Mr. MORDEY regretted that Mr. Swinburne's Paper was not printed so fully as it was read. He did not agree with Prof. Forbes as to the result of reducing cross-induction by the methods shown in Figs. 3 and 4 (*The Electrician*, February 14, p, 375) of Mr. Swinburne's Paper; in fact, he considered the plan quite natural, and it was very effective in well-designed machines. He thought that subsidiary or reversing pole-pieces would not

Digitized by Google

be practical, and that sparking is generally due to overloading; a better plan of preventing sparking would be to utilise the additional length of armature which the pole-pieces require, for lengthening the main core, thereby reducing overloading.

Mr. SWINBURNE here pointed out that the devices were not merely to prevent sparking but to reduce the back turns, thus diminishing or rendering unnecessary the series windings on compound machines for constant E.M.F.

Mr. MORDEY (continuing) referred to "small air-space dynamos," slip 12, (*The Electrician*, February 21, p. 401), and said Mr. Swinburne was once a great advocate of such machines, as well as of "large-output dynamos." However, as far as he was aware, no great progress had been made with either variety, for makers seem to have come back to machines having moderate air-spaces and of moderate output. Speaking of "high-tension constant-current dynamos," he said many difficulties were met with in smooth commutator machines under varying load. The Brush machine had been shunt wound for arc lighting, and many machines were so acting, but the plan was only suitable for special cases. For light loads it was unsuitable, and, on the whole, the series method was best. As to the heating of the pole-pieces, he pointed out that there were two causes of unequal heating—one was the action of magnetic tufts, which always heated the same pole, the trailing horn; the other, and more important, was the action set up by the current in the armature coils. The pole heated most by this latter cause was behind the brush in a generator, but in front of it in a motor. Thus, if a Brush machine is run with the brushes in the same place as a motor as when used as a dynamo, as may be done by reversing the field, the same pole-piece will heat in both cases; but in a motor the heat will be less, because the two causes of heating referred to are not acting on the same pole. In a dynamo the effects are added, in a motor they are subtracted. In discussing methods of measuring temperature of machines, he said this was sometimes done by measuring the resistance of the armature when hot; but this was not to be relied upon, for owing to expansion and consequent change of contact resistance at the soldered joints, the resistance hot might be less than when cold. Referring to Prof. Ayrton's remarks on the construction of "light-weight motors," Mr. Mordey said such machines were like "large-output dynamos" in not being successful in practice. He then read abstracts from Profs. Ayrton and Perry's Paper on "Electromotors, &c.," which in his opinion had retarded rather than advanced motor design. He contended that both in dynamos and motors an armature which produces no appreciable field is the best. As regards "magnetic lag," he said that any such ag of practical importance would prevent E.M.F. being proportional to speed. Experiments on a Victoria Brush machine showed that from 200 to 1,200 revolutions per minute the E.M.F. curve was a straight line, in spite of the eddy currents, which increase as the square of the speed.

Prof. AYRTON here remarked that Dr. Thompson, who agrees with Mr. Mordey as to the non-resistance of magnetic lag, entirely disagrees with him on the question of E.M.F. being proportional to speed.

Mr. MORDEY, in reply, said he was not answerable for Dr. Thompson's statements, but he was quite sure that in well-made machines he had tested the E.M.F. was exactly proportional to speed.

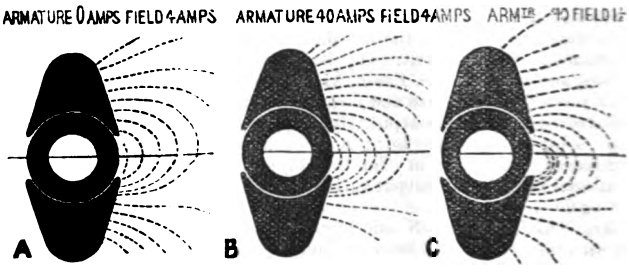
Mr. W. B. SAYERS questioned the accuracy of Mr. Swinburne's view of the action of coils short circuited by the brushes given on slip 11 (*The Electrician*, Feb. 21) and thought the various statements were not consistent. The real effect was a diminution of the induction in dynamos and an increase in motors. He had made many experiments on the subject, and invariably found that for a given speed and current the E.M.F. of a machine run as a motor was greater than that when used as a dynamo, and the same thing is shown, with one solitary exception, in Table IV. (*The Electrician*, March 21, p. 495) of Mr. Esson's Paper. Laminating the cores has the effect of decreasing the divergence. One serious cause of sparking which had not been referred to in either Paper was the want of accuracy in making all the sections and commutator bars exactly alike, and spacing them with rigorous exactness round the armature. In his opinion nothing short of the accuracy obtained by engineers in cutting wheels would effectually overcome sparking. Neglect of such precaution causes variation in the non-sparking position, the result of which may sometimes be seen in some segments being marked whilst the others remain perfect.

Mr. CROMPTON said he wished to bring forward a few novelties not mentioned in either of the valuable Papers under discussion; for although these Papers deal with many interesting and important points in dynamo design, they do not say how the best machines of the day are being made. Several firms, notably, Messrs. Siemens, he said, were turning out dynamos having efficiencies undreamt of several years ago. The results mentioned by Mr. Willans, for example, of a combined engine and dynamo efficiency of 84 or 85 per cent., showed that the commercial efficiency of the dynamo must be quite 93 per cent. The cause of the high figure, he believed, was to be found in the much-abused Admiralty specification, for all firms anxious to secure contracts had been obliged to devise means for reducing the rise of temperature, the result of which was greatly increased efficiency. In making large machines difficulties presented themselves which were unimportant in small dynamos; for example, as pointed out in Mr. Swinburne's Paper, the magnetic leakage across the internal cavity of Gramme armatures becomes serious. On the whole, he was inclined to agree with Mr. Swinburne's remarks on the disadvantages of Gramme as compared with drum armatures. Some doubt, he said, still exists as to the necessity of insulating the driving bands of drum armatures from the shaft; in his opinion it was not necessary. The question as to what material should be used for transmitting the driving strain from the shaft to the armature required careful consideration; he himself found aluminium-bronze and delta metal fairly satisfactory, for they combine good mechanical strength with high electrical resistance. Another point requiring particular attention was the subdivision of the armature conductors in machines for large currents. The heating of the conductors in "bar armatures" due to Foucault currents may be considerable; but by subdividing the bars into sections, and twisting them through half a turn, he had succeeded in largely reducing this effect, to about half its former value. A further improvement consists of forming the conductors from a great number of wires twisted together, and compressed into a trapezoidal form of the proper shape for the winding. In illustration of the various methods of subdivision above referred to, Mr. Crompton exhibited specimens of conductors made by his firm. Speaking of the arrangement of the radiating surfaces or armatures, he said the question, does it pay to cover all the surface of the core with copper, or to leave spaces between the sections to give increased surface was still open to discussion.. Referring to Mr. Mordey's statement about the lessened resistance of hot armatures, he said he had never observed such an effect, and thought the joints in machines exhibiting such peculiarities must have been defective. In conclusion, Mr. Crompton replied to Mr. Esson's remarks on slip 12 respecting dynamo No. 4, Table II. (*The Electrician*, March 14, p. 475), by saying that this was the first machine in which the design had been influenced by the idea of magnetic resistance, and he was glad to see that its armature was the father of all modern ones of the Gramme type. In support of this he pointed out that the ratio of radial depth to diameter was 1 to 5, a proportion now almost universally adopted.

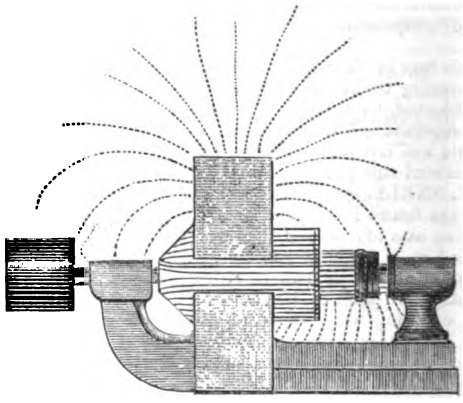
The discussion was then adjourned to the 20th inst.

MARCH 20.

Mr. A. P. TROTTER disagreed with Mr. Esson's statement on slip 2 (*The Electrician*, February 28th, page 424) as to the inutility of and the difficulties attending calculations of the stray field, and said that since Prof. Forbes gave his three Lemmas in 1886, the work has been comparatively simple, and constituted part of the drawing-office routine at Halifax. Speaking of differences in the quality of iron, he said forged bars could be depended on, but charcoal iron was not so reliable. Any doubt as to the behaviour of iron, in his opinion, renders it all the more necessary to calculate the waste field, so that only one unknown factor may be present.



Stray-Field Diagrams.



Stray-Field Diagram D.

This predetermination is most important when any departure from ordinary designs is made, for in such cases one cannot be guided by previous experiment. As an instance of the accuracy attainable in these calculations, he said that in Messrs. Goolden and Co's. M type dynamo, where the leakage amounts to 60 per cent., Mr. Ravenshaw predicted this to within 1 per cent. Mr. Trotter also exhibited some interesting diagrams plotted by a novel method on the machine itself, which showed the directions of the waste field under various conditions of armature and field excitation; on one of these the distorting effect of a large armature current could be easily seen. From such diagrams, A, B, C, D, combined with Prof. Forbes' formulæ, the speaker was of opinion a line could be determined, in terms of whose length the magnetic resistance between any two parts considered may be stated.

Mr. VIGNOLES confirmed Mr. Trotter's remarks about the calculations of waste field by Mr. Ravenshaw. He also pointed out that Mr. Esson used the word "saturation" in various senses, and he thought it desirable that a distinct meaning be given to the word by definition.

Mr. S. JOYCE, speaking of Mr. Esson's rule for rise of temperature, said such rules could only give the temperature at the surface, and not that of the interior, which was probably much greater. As the difference in temperature between the inside and outside of the winding varies as the square of the depth, this difference may become excessive in large machines. The expression for the difference on the assumption that the inside and outside sur-

Digitized by Google

face are parallel planes was given as $\frac{h D^2}{2K}$, where h = C.-G.-S. heat units generated per cubic centimetre, D = depth of winding, and K its thermal conductivity. For cylindrical surfaces of ordinary dimensions, the difference is about 3 per cent. less. The quantity K may be calculated from the equation $K = \frac{Z d}{Z\delta}$, where Z is the thermal conductivity of the insulating material, d the diameter of the covered wire, and δ the radial depth of insulation. The speaker said the value of Z given for cotton by Prof. Everett was ·00201, by Prof. Forbes ·00003; but he himself found it ten times the latter, viz., ·0003. His own experiments on "emissivity" of varnished cotton gave the number ·0005, whereas Macfarlane's result for blackened copper was ·0003. He had also found that by leaving about 10 per cent. of armature cores exposed, the difference of temperature between the inside and outside of the winding was reduced to a quarter that which exists when the whole surface is covered with wire.

Mr. J. D. F. ANDREWS said the specimens of armature winding exhibited by Mr. Crompton were very interesting, but thought the heating difficulty could be got over in a simpler way. In one dynamo he had constructed with bars ⅜in. by ⅜in. the heating was immense when running at no load. On cutting away the pole-pieces tangential with the armature the rise of temperature was 100° Fahr., and by putting the bars on edge this was reduced to 30 deg. After rounding off the top corners of the bars there was no heating.

Mr. STUART A. RUSSELL, referring to Mr. Esson's curve for maximum output (Fig. 21) (*The Electrician*, March 21, p. 495), said he believed this was obtained on the assumption that the depth of winding inside the armature was equal to the depth outside. If the difference between these depths be taken into account, then in ordinary cylinder armatures, instead of the core being about four times the depth of the winding, it becomes 5¼ times. As regards size and output the speaker said he had found the rule—total induction $\propto$ (watts per revolution)$^{\frac{3}{4}}$—very convenient, and that it nearly agreed with that given by Mr. Snell. Referring to the difficulty in compounding slow-speed machines, Mr. Russell said one cause arose from the want of proportionality between the additional ampere-turns on the magnets and the back ampere-turns on the armature. In the former they are proportional to the current simply, whilst in the latter they are proportional to the current multiplied by the angle of lead. Hence, if the compensating turns are made right for full load, then the middle of the curve will be too high. Concerning the design of motors, the speaker said he agreed with the authors of the Papers, but the startling nature of the curves shown by Prof. Ayrton had led him to make experiments on the subject. In these a double horse-shoe Gramme machine was used with the magnets, and armature currents decreased and increased 40 per cent. respectively, so as to obtain a relatively powerful armature. In addition to taking volts and amperes, the field was measured by the ballistic method. The first set of experiments was made with brushes of the ordinary thickness (1¼ segments). The results showed that with no lead V – C R as a motor was about 8 per cent. greater than V + C R as a generator, whilst with lead and trail of 18 deg. the difference was 4 per cent. This difference, he believes, is accounted for by self-induction, for there was very little change in the field-induction. In a second set of experiments two brushes in parallel arranged so as to short-circuit four sections, were used; the difference between V – C R and V + C R amounted to about 75 per cent. of the mean, but it was also noticed that the change in the field only amounted to about 30 per cent., and that V – C R as a motor was greater than the E.M.F. corresponding to the induction used. From these observations Mr. Russell concludes that the E.M.F. of a motor may be made greater than that of a dynamo by short-circuiting a number of sections, thereby increasing the armature induction; but that no advantage is gained, because the result is just the same whether the greater induction is produced by field-magnet windings or by coils short-circuited by the armature brushes. His experience with motors having thick brushes did not agree with Mr. Snell's, for in tramcar work he (the speaker) got the best results with brushes of ordinary thickness.

Mr. WYLES said no doubt need exist as to the possibility of making smooth commutator machines for high voltages, and that the difficulties experienced arose from the great differences in the insulation of similar machines. The insulation of some may be excellent, whereas that of others wound with equal care is comparatively bad. These differences are met with in machines of E.M.F.'s as low as 200 volts.

Mr. GEIPEL asked whether cross induction could not be reduced by cutting the pole-pieces in Fig. 3 of Mr. Swinburne's Paper (*see* diagram in the discussion of March 13) in two parts at E E, and by laminating the magnets in a direction perpendicular to that of the cross lines. Referring to Mr. Eson's temperature limit of 75° C., he inquired whether any modification would be made for machines intended for tropical climates.

Dr. S. P. THOMPSON, in a communication read by Mr. KAPP, said a good approximation to the back ampere-turns was got by multiplying the number of conductors between the pole corners by half the armature current, and that he agreed with Mr. Swinburne as to the usual position of the brushes. He complained of Mr. Swinburne's use of "ergs" in measuring magnetic potential, and asked why in naming the pole corners he had reversed the ordinary usage. He also inquired why Mr. Esson takes the load carried by armatures as proportional to the depth of armature core. Speaking of "leakage coefficients," he pointed out that this is not constant even for machines of the same type, but is less for the larger machines. Referring to the statement by Mr. Esson that the induction in large armatures should be less than in small ones, Prof. Thompson asked whether this was true both of disc and wire cores. As regards smooth commutator machines for high volts, he said Messrs. Paterson and Cooper had made such machines successfully for some time, and that in Ball's so-called "unipolar dynamo" was an instance of a smooth commutator machine working 80 arcs in series.

Mr. MACWHIRTER objected to Mr. Swinburne's use of the symbol Ω for magnetic potential, for this was the recognised symbol for megohm. He also said that some system of symbols was greatly needed, and suggested that the Nomenclature Committee appointed by the Society some five years ago should present an interim report. Speaking of the magnetic pull on armatures of single-magnet machines, he said his firm found the method of placing the armature eccentrically very effective. Their motors were always made on the same lines as dynamos, for they found that machines with light fields always sparked.

The PRESIDENT expressed his great appreciation of both Papers under discussion; but, owing to the lateness of the hour, would only criticise a few points in Mr. Swinburne's. The rule given for lead of brushes seemed to him hardly correct, for in machines with which he was acquainted the lead was always less than half the angle between the pole corners. There were two points to which he wished to direct Mr. Swinburne's attention, viz., the effect of having a great or a smaller number of commutator bars, and of thick or thin brushes. Speaking of the term "magnetic resistance," he said there were two reasons why he did not use it; first, the generally accepted idea of *resistance* was that (*flux*)^2 × *resistance* was a rate of doing work; so-called "magnetic resistance" did not satisfy this condition; secondly, "coefficients of resistance" are generally constants, and express properties of the material or medium. "Magnetic resistance," however, is by no means constant, and he thought its use open to the same objections as "resistance of an electric arc," an expression which was very misleading.

Mr. SWINBURNE, in reply, said the main subject of his Paper had not been discussed. Its object was to show how to obtain an expression for the lead of the brushes in terms of the polar angle, and thus determine the back induction before the machine was made. This being of much greater importance in regard to large machines, the greater part of his Paper referred to such machines; but, unfortunately, many of the speakers assumed it applicable to small machines, and discussed it accordingly. Prof. Ayrton, he said, had accused him of using "magnetic potential" where "difference of magnetic potential" was meant. This he denied, and pointed out that he had been careful to speak of difference of magnetic potential. Referring to "magnetic lag," he said the "time lag" discovered by Prof. Ewing had no connection with the once supposed lag to which the lead of the brushes was wrongly attributed. As regards the results of experiments on machines run as generators and motors by Prof. Ayrton, he pointed out that in those experiments where the E.M.F. became negative with a large armature current, the generator became a motor, and the brushes were then in the wrong position. He also contended that, in all cases where the E.M.F. of a motor increased with increase of armature current, the brushes were not in the proper position. He believed Mr. Esson's results on the Bürgin machine were due to the same cause; for in this machine, unless made specially as a motor, the brushes could not be put back far enough to run sparklessly. Probably Mr. Esson had been misled by not being aware that the commutator connections are skewed. Replying to the criticisms on his use of "ergs" in measuring magnetic potential, he said Sir W. Thomson was the first to introduce it, and as it had been used by Maxwell and others, he thought he might use it too. His objections to "magnetic resistance" are—1st. That the term has no definite meaning; 2nd. that the analogy whence it is derived is wrong; and 3rd, if used, it is liable to lead to error, as has already been the case with regard to transformers. Magnetism, he said, was analogous to electrostatics, and permeability to specific inductive capacity, not to conductivity, as the advocates of magnetic resistance would have us suppose. Referring to Mr. Kapp's remarks on enlarging dynamos to scale, he said that the impossibility of doing so successfully had been pointed out seven years ago by Dr. Hopkinson, who about that time got three times the output at present obtained by Mr. Kapp and others from machines of the same weight. In his opinion four-pole drum machines would be used in the future for large power outputs. Speaking of the Admiralty, temperature test Mr. Swinburne said it was comparatively useless, for it failed to pick out the best machines. To do this the temperature of the conductors should be ascertained, and this could be done by taking the resistance of the armature in spite of Mr. Mordey's bad joints. He was sorry to learn that Mr. Mordey had not been able to make a shunt brush machine work successfully, for he himself had done so, and the inventor of the machine approved of the arrangement. As regards the position of the brushes relative to the pole corners he pointed out that Dr. Thompson's observations agreed with his own, and not with those of the President. In answer to the President's inquiry why he did not integrate to infinity, he said the integration had only been given as a rough approximation near enough the truth to show that a comparatively weak field is required to reverse the current in the armature sections of direct-current machines. If alternating machines were under consideration the treatment of the integration would be much more important.

Mr. ESSON, in his reply, said Mr. Kapp's method of overcoming side pull had the disadvantage of not allowing the coils to be slipped over the poles, and that even if adopted the distribution of the field was not the same near the top brushes as near the bottom ones; the arrangement in Fig. 9 (*The Electrician*, February 28, p. 426) gave a much more uniform field. He could not understand how Mr. Kapp saw any "dodge" in designing armatures to give large outputs, for the magnets were designed in accordance with the armatures with which they had to work. Neither could he understand Mr. Ravenshaw's remarks about the loading of armatures. In his opinion the machines of a set could not be all in the same condition as regards balance of field, and he thought all Mr. Ravenshaw's dynamos were underloaded. He was glad to see that Prof. Ayrton's remarks respecting the number of ampere-turns required for compounding agreed with his own statement on the subject. Speaking of the Admiralty test, he said the method of making the test was to heat the thermometer 30° Fah. above the surrounding air before applying it to the

Digitized by Google

armature, and then noting its rate of rise or fall when so applied. Machines giving a rise of 40 deg. were accepted subject to a fine. He was now of opinion that the rise allowed by the Admiralty was quite enough for machines which had to work in hot engine-rooms. Referring to Mr. Crompton's armature conductors, he said he had used stranded wire for the same purpose ; but the section of his subdivided conductor was round, and not made rectangular, as in Mr. Crompton's. He would have been glad to learn something about the collection of large currents, for this seemed to be one of the most difficult problems at present. On the subject of motor construction, Mr. Esson said Prof. Ayrton's curves showed that it was difficult to prove either point conclusively ; however, he thought he could see where Profs. Ayrton and Perry had been led into error. In their Paper on Electromotors, &c., the output of a machine is given as

$$W \propto (L\,l \cos \alpha + l^2 \sin \alpha),$$

where L and l are the weights of the magnet and armature respectively, and α the angle of lead. In order that this may be a maximum for a dynamo (where the negative sign is to be taken), L must be large compared with l, but in dealing with motors, the Professors said the + sign should be used, and this led to the large armature view. Mr. Esson, however, contended that the negative sign is the one to be taken for both dynamos and motors. The positive sign, he said, leads to bad machines, which always spark.

APPENDIX.

The following are copies of the letters respecting the "Wood" and "Sperry" dynamos referred to by Mr. Esson in his Paper.

W. B. Esson, Esq., London, England.

DEAR SIR,—In reply to your letter of October 21st, requesting data of machines made by this company, I send you the following :—Difference of potentials at terminals of machine, 2,640 volts ; current, 9·6 amperes ; revolutions per minute, 875 ; sections in commutator, 120 ; convolutions per section of armature, 72 ; cross section of iron in armature ring, 14 square inches. Pole-pieces are bored concentrically with the armature ; sparking at the brushes is eliminated by the use of an extra brush connected to collecting brush, with a separation or commutator of from five to ten sections, depending on the load, or, in other words, a counter E.M.F. to reduce spark. I must apologise to you for the delay in answering your letter, and hope that I may be in time for you to make use of data as intended.—I am, yours truly, CHARLES J. BOGUE,

The New American Electrical Arc Light Company.

New York, Dec. 2, 1889.

Mr. W. B. Esson, West Hackney, N.E., London.

DEAR SIR,—Yours of October 21st at hand. Am pleased to notice contents, and in reply would say that the matter of regulation by shifting the brushes I have gone into as exhaustively, perhaps, as anyone in this country. I have had unlimited capital at my disposal, and have made an exhaustive series of experiments, and can say from knowledge that it depends for its success almost solely upon what we know as the balance between the armature and field. This might more properly be termed the preponderance of the induction of the field over that of the armature. . . . In the machines we build, the brushes can stand in any position from 0 E.M.F. to full E.M.F. without a particle of sparking upon the commutator, the commutator wearing smooth, and glazing over with any position of brushes.

The machine at the Paris Exposition is a 14in. machine—that is, the exterior dimension of the armature is 14in. The actual exterior dimension of the core when ready for winding is 13½in.

The normal speed of machines of this size is about 1000 revolutions. The E.M.F. of the armature at the brushes, before going through the fields, is about 620 volts, with ten amperes in the fields.

The internal dimension of the core is 10⅛ inches, and the length of the core is 6¼ inches. The insulation in mass of core is 20½ per cent. There are 72 sections in the commutator. There are four layers, with ten convolutions in each layer of wire upon the armature. From these dimensions you can get the actual area of iron.

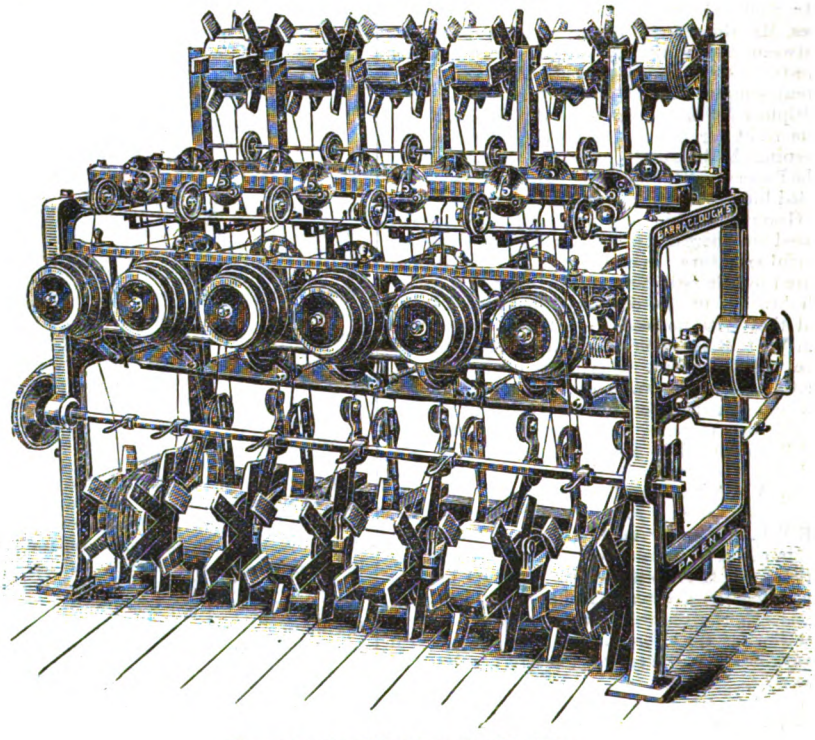
The field is bored perfectly concentric with the armature, and a good liberal clearance is allowed, usually about $\frac{5}{32}$ of an inch exterior to the bands of the armature—perhaps $\frac{1}{32}$ less in the case of small machines.—Yours very truly, ELMER A SPERRY.

Chicago, June 11, 1889.

BARRACLOUGH'S WIRE-COVERING MACHINE.

Among the recent improvements in machinery for insulating and covering electric wires and strands, the machine made by Messrs. Thomas Barraclough and Co., of Globe Works, Manchester, which we illustrate below, shows a considerable advance in the process of covering wires with cotton and other fibrous yarns.

The great desideratum in this branch of manufacture is to obtain a perfectly even covering—the wires must show no inequalities, no thin or thick places ; and in order to effect this the yarns used must be of good quality and even spinning, and the application of the yarns to the wires must be faultless. Considerable difficulty is experienced in arriving at a perfectly even covering, by reason of the breakages of the yarns, the carelessness and want of skill of the operative, and also by defective machinery. The covering heads revolve at a very high speed, the yarns are liable to break, and the bobbins frequently become empty, causing inequalities in the covering, more especially when the attendant fails to observe the breakage or failure of the yarn. The machine has therefore to be frequently stopped, the broken yarn or yarns pieced up, and fresh bobbins inserted in the flyers. During this operation the whole machine is standing still, necessarily involving great loss of production.



Barraclough's Wire-Covering Machine.

The object of this invention is twofold :—1. The construction of wire-covering machines in such a manner that each covering head can be worked and stopped quite independently of the others ; thus, if from any cause one head is stopped, the others are not affected, but continue their work at full speed. 2. The application of an automatic stopping apparatus to each flyer, so that as soon as a thread breaks, or a bobbin becomes empty, the head stops auto-

Digitized by Google

matically and instantaneously, thus preventing imperfect work, and enabling the operative to see at a glance which head needs attention. These machines are usually made with six heads to cover six wires simultaneously, and each head has two flyers with automatic stop motion, arranged to run in opposite directions, so as to apply two coverings to the wire, right and left hand. These heads are quite independent of each other, and can be stopped and started at will.

The following description of one head of the machine will render the mechanism clear to our readers. On the driving shaft, which extends along the machine, a number of discs are keyed, there being one to each head. Adjoining each disc, and to a certain extent covering it, is a grooved pulley. One side of this disc is hollowed, and has a circular leather plate fixed in it, which acts as a frictional surface by which the grooved pulley is driven when pressed up to the disc. Over the pulley an endless band is passed, which drives the two rotating covering flyers in opposite directions. The grooved pulley can be slid upon the shaft by means of a lever, by moving which to the left contact of the frictional surfaces is established, or *vice versâ*. The wire is drawn from the reels—shown in place at the upper part of the machine—and is passed through the hollow spindles of the covering head, after which it follows the course shown until it reaches the draw roller, on which it is taken several turns. The rate of rotation of the draw roller regulates the speed of covering, and the reels upon which the covered wire is wrapped are driven by a band from the shaft on which the draw roller is fixed, so that the speeds of the two are relatively proportionate. The covering material is carried in spools fixed upon pins fastened in the face of the covering flyers. Instead of driving the draw roller shaft by bevel gearing, it is driven by a worm and worm wheel, the former being fixed on the driving shaft. In this way a regular speed of draw-through is obtained, entirely free from the irregularities arising from back lash when ordinary gear wheels are used. This is of the utmost importance to ensure perfectly even covering. The stop motion consists of a small finger attached to the covering flyer in such a way that as the latter is rotated the finger tends to assume a perpendicular position. It carries an eye through which the yarn is passed, the tension upon the latter being sufficient to prevent the finger from taking the position named. As soon as a yarn breaks the finger assumes the perpendicular, and in its rotation strikes one end of a small lever, which is oscillated through an arc of 90deg. The movement communicated to the small lever causes a small mechanism to descend and press a weight, which is suspended by a cord in the slot of a large lever. On the latter is a projection, in front of which the weight is forced, and is thus brought into the path of a cam on the driving shaft. In this way the lever is pressed back, and by means of a connecting rod it raises and releases a small lever, so that it can be drawn over by a spring, and the section is thus stopped in the manner previously described. To re-start the machine it is necessary to piece up the thread and restore the levers to their original position. This is done by a small lifting rod specially provided and arranged to act for both discs.

The machine has met with considerable success, supplying, as it does, a long-felt want; the manufacturer is rendered in a large measure independent of highly skilled labour, whilst the production is relatively much higher than that of other machines, because when one head is stopped the other heads are unaffected thereby. An additional advantage connected with this machine consists in the wide range of thicknesses of wire which can be covered.

ENGINEERS', ELECTRICIANS', BUILDERS', AND IRONMONGERS' EXHIBITION.

Since our previous visit many electrical and engineering exhibits have been added, making the Exhibition complete. Those interested will find a number of excellent displays of electrical and general fittings, instruments, &c., &c.; and of these more particular mention may be made of the stand of Messrs. O. Berend and Co., who have on view some elegant specimens of the metal workers' art, mostly the manufacture of German firms represented here by Messrs. Berend. They also show electrical measuring instruments from the well-known works of Messrs. Hartmann and Braun, of Bockenheim, Frankfort-on-the-Main, and they have a good display of Saxonian bronze ware, for which they are the sole agents in the United Kingdom. At Stand 28, Messrs. Richard Anderson and Co. have on view a good assortment of lightning conductors of all kinds.

The Consolidated Telephone Construction and Maintenance Company (Limited), at Stand 62, show in a small space a large number of telephones, including the Fitzgerald combination telephone, the consolidated telephone, the consolidated magneto-disc telephone, the Austrian consolidated telephone, the Bell and Blake magneto telephone, diving apparatus telephones for submarine communication, and annunciators, call bells, switches, &c., &c., making an imposing exhibit.

Messrs. Richard Johnson, Clapham, and Morris have on view at Stand 74 various specimens of telegraph, telephone, and electric light wires, as well as a number of samples of Johnson's patent rolled wire-lathing, a substitute for wooden laths. It is claimed for the lathing that it will make a building practically fire-proof at a small cost. The makers have several excellent testimonials, one being from a firm in the provinces, who state that a ceiling made of these laths was practically uninjured after being subjected for an hour to intense heat and streams of cold water at a fire which occurred on their premises.

Messrs. Winnall, Callow, and Winnall have since our previous visit completed the installation of the electric light at their Stand 172, and show a number of Newall engines, one of which is driving a 3-unit Phœnix dynamo. The firm claim that the engine has now been perfected, and is especially suitable for electric light purposes. The British Gas Engine Company have at work at Stand 155 a 4 horse-power Atkinson patent Cycle gas engine, driving a 60-volt Statter dynamo direct, supplying a small installation of incandescent and arc lamps; the engine was working very steadily, and Mr. Atkinson informs us that the company are exceedingly busy filling orders. Messrs. Dick, Kerr and Co. have now put down the large Griffin gas engines, which are employed in running a Tyne dynamo (manufactured by Messrs. Ernest Scott and Co.), and a Phœnix dynamo (Messrs. Paterson and Cooper), supplying current to a number of Kent arc lamps.

The Exhibition remains open till to-morrow (Saturday) evening.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *March* 15, 1890.

A Novel Storage Battery.—Messrs. Justus B. Entz and William A. Phillips, of Schenectady, New York, have just been granted a patent for a distinctly novel type of storage battery plate. It consists of a flexible wire, around which is woven a network of finer wire, the metallic oxide being embedded in the meshes of the latter. The plate can be employed either as the negative element of a zinc and carbon primary battery employing a solution of caustic potash, when the hydrogen set free in the cell, tending to coat the plate, will combine with the oxygen in the oxide, depositing pure metallic copper in the meshes of the net-work; or, the same plate may be employed as the negative element of a storage battery, the copper oxide serving as the active material which receives its liberated oxygen during charging. This plate, it is claimed, is uninjured by even the heaviest discharges.

Thomson Electric Welding Process in the Navy.—A very favourable report has been issued by a Board, consisting of Commander George A. Converse, A. S. Greene, Assistant Naval Constructor S. W. Armistead, and Ensign Gilbert Wilkes, U.S.A., appointed by the Secretary of the Navy to investigate and report upon the Thomson welding process. After thoroughly testing and investigating the theories and principles involved, the Board states:—"We are convinced that the Thomson welding process can be found of great utility to the naval service both ashore and afloat, as it can be used for welding breaks in rods without altering them either in length or shape, for welding tubes, angles, and shapes of intricate form, copper, brass, cast-iron and other metals, for heating metals for forging, tempering, and upsetting, and for welding wire cables, and rendering easy many operations in the working of metals which, with a forge and smith, have heretofore been considered impossible." They also remark that as the classes of work at naval stations and on shipboard differ materially, welders designed for use in the two places should be constructed in accordance with the work required of them, those for use on board ship being designed especially to embody lightness, compactness, and general adaptability to the various classes of work which they may be called upon to perform.

The Waite Indicating Dynamometer.—An exceedingly ingenious and novel power meter and indicator has been devised by Mr. Guy Waite to meet the want of an instrument which shall depend upon principles of perfect accuracy, and shall be independent of the elasticity of solids such as springs, the variations

Digitized by Google

of which are a constant source of error; and, further, one which can be readily applied to the machine which it is desired to test, without obstructing any work that it may be at that time performing. This has been accomplished by employing air to receive the power from the shaft, and convey it to the driving pulley of the machine, the power consumed by which is being measured. In the latest type the compression of the air caused by the pull on the belt is in direct communication with a new form of stationary gauge, whose indications may be noted with a great degree of precision. These indications on the gauge are electrically communicated to a recording device, which may be placed at any distance from the machine. The contacts of this apparatus are governed by a rotation of the shaft, by means of which the product of the pull on the belt by the rotation is recorded in an ordinary manner on a system of discs. If it is desired, as in the dynamo, to know how the horse-power varies and what it is at different times under change of load, a continuous diagram of the horse-power transmitted may be taken, showing a record for all times during operation, and also recording the work which is being done. For obtaining a continuous diagram of the horse-power a "speedometer" governed by centrifugal force is made use of.

The Argument on the Right of the City to Transfer the Business of Building the Subways.—This case was argued before Judge Andrews in the Supreme Court on the 5th inst., a large number of legal celebrities and representative electric light men being present. The Manhattan, East River, Northern New York and Mount Morris Electric Light Companies, and George E. Armstrong, taxpayer, moved to have the injunction, granted by Judge Patterson against the Mayor, the Board of Electrical Control and the Consolidated Telegraph and Electrical Subway Company, made permanent, thereby restraining the Mayor and Board of Electrical Control from authorising the transfer by the Consolidated Company of its rights and property to the Standard Company or any other company, and enjoining the Consolidated Company from making such transfer. The vital importance of the issue of the contention to the plaintiffs was dwelt upon by Mr. Nicoll, their eminent counsel, and it was stated that if the proposed arrangements were carried out they would inevitably be driven out of business. The terms of the contract were that the companies should furnish the capital and give suitable bonds. Thirty miles of subways have now been built under this contract. Mr. Nicoll divided the electric light interests of the city into three classes:—The Edison Company, the right to build subways for which is reserved by the Consolidated Company; the Westinghouse interest, which controls the Standard Company, and which includes the Brush Electric Light Company and the United States Illuminating Companies; and the companies other than the Westinghouse, for which companies he appeared. The learned counsel concluded his argument by contending that the Standard Company so far existed only on paper, and contested that the Board of Electrical Control has no power to make another contract, because no breach of contract has been made by the Consolidated Company; and, further, if it has the power to make another contract it cannot authorise the sale or transfer of the subways constructed by the Consolidated Company. Mr. W. N. Cohen, speaking for the Consolidated Company, said that the question of their motives in selling their subways was none of Mr. Nicoll's business. Their money had built them, and they had a right to dispose of them as they saw fit. With reference to the contention of the plaintiffs that their business would be crippled under the new conditions, it was only necessary to remember that the rules controlling those conditions were made by the Board of Electrical Control, and could be changed by the same authority, which would prevent any injustice. It was contended by Mr. Dean that the Board of Electrical Control had power to make new contracts, as the Consolidated Company had been unable to do the required work. Mr. Bourke Cochran, of electrical execution notoriety, stated that the whole proceeding was an attempt of the Manhattan Electric Light Company to extort money from the new Standard Company. This was denied by an affidavit put in on the following day on the sitting of the Court from Mr. Bernheim, of the Manhattan Company. It will be a week or ten days before a decision on the argument can be rendered.

PARIS NOTES.

(FROM OUR OWN CORRESPONDENT.)

March 24, 1890.

At the last meeting of the Conseil Municipal it was decided, after some discussion, to extend the concessions for the electric lighting of the Grands Boulevards and of the Rue Royale and Rue Saint Lazare until April, 1891. The lighting has not been of a very satisfactory character, and the extension of the concessions has been granted with a view of enabling the authorities to see the light at work under better conditions before coming to a final decision in the matter. The charges are to be reduced by about 50 per cent., and will be 50 centimes the lamp-hour in the case of the Société Edison, and 45 centimes the lamp-hour in the case of the Société Popp and the Société du Transport de la Force. The number of lamps will be increased from 104 to 131.

The results of the meter competition inaugurated by the municipality of Paris has at last been made public—M. Cauderay 2,000fr., M. Aron 2,000fr., M. Brillié 2,000fr., M. Blondlot 1,000fr., and M. Jacquemier 1,000fr. A new competition, in which any of the above instruments may take part, was officially announced at the same time. [A copy of the rules and regulations in connection with this competition will appear in our next issue.—Ed. *E.*]

The three experts who are to assess the value of the telephone material of the Société Générale des Téléphones are M. Daymard, M. Potier, and M. Paul Josselin, nominated respectively by the Société, the Government, and the Conseil de Préfecture.

The installation at the Asile des Aliénés de Vaucluse has now been in successful operation since November. It comprises nearly 600 lights of 10 and 16 candle-power, and the current is supplied by three compound-wound Desroziers dynamos, giving 740 amperes and 122 volts at 850 revolutions. Owing to the loss in the leads consequent on their great length, the dynamos have been over-compounded, and their terminal E.M.F. varies from 100 to 122 volts, as the current varies from 0 to 130 amperes.

CORRESPONDENCE.

DYNAMO AND MOTOR DESIGN.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I was prevented by illness from attending the discussion on the Papers read by Messrs. Swinburne and Esson at the Institution of Electrical Engineers. I have, however, heard that besides the assertions in these Papers, other assertions were made during the discussion to the effect that the well-known Ayrton and Perry rule concerning motors and dynamos was "nonsense." Even if the persons who use language of this kind gave some reason for their assertion, or showed in any way that they had read our Paper on "Motors" (*The Electrician*, August 11, 1883, *et seq.*); or, at all events, had tried to understand it, I would deprecate the use of such language.

I have been led to read carefully those parts of the Ayrton and Perry Paper on "Motors" which deal with the armature action on the field; and I have been greatly astonished to find that at the date of that Paper, seven years ago, such sound views were held by us. It is a Paper which contains almost everything that has been written since upon the subject, including the Papers of Messrs. Swinburne and Esson. I am not greatly concerned when I find that my views do not meet acceptance from the members of our profession, and, as a rule, I care very much less about what I have done than about what I hope to do. But I had forgotten the "Motor" Paper, and have been compelled to study it, and I cannot restrain my admiration, which is that of a nearly unbiassed critic.

Since the publication of Dr. Hopkinson's theory of the magnetic circuit of a dynamo it is obvious that the statement

$$F : A :: \frac{WC}{1+SC} : \frac{W'C'}{1+S'C'}$$

is antiquated. It is much better to take, as we do in page 35, F and A as the ampere-turns on the field-magnet and armature respectively. In either case, page 35 is right so long as saturation is not approached. When saturation is approached, instead of taking the above antiquated expressions, we have now simply to say that

$$F \cos\phi \mp A \sin 2\phi$$

Digitized by Google

represents the total ampere turns producing the actual field to which the E.M.F. is proportional. It will be observed that every curious result obtained by Mr. Esson and other experimenters which have appeared to be so complicated and difficult to understand, are at once obvious from the expressions we have given.

I presume that it is now too late to get any of our assertive critics to really read the Paper on "Motors." They simply say that there is no difference between a dynamo and a motor. Is it too much to ask them to study the following statement? It puts the whole disputed position in a nutshell.

Imagine a machine in which the armature current increases the field. Obviously the coil which is just about to be short-circuited has an E.M.F. acting in it which is in the same direction as when this coil was acting most usefully—that is, if the machine is a motor this E.M.F. is *opposing* the current. But this is the very kind of E.M.F. which is required when a coil is being short-circuited if sparking is to be destroyed. Now imagine the same machine to be a dynamo, and speak again of a coil which is just about to be short-circuited; the E.M.F. in this coil is in the direction of the current, and this is the very kind of E.M.F. which will cause destructive sparking. Thus, then, even if we assume no time-lag of magnetism—which I firmly believe in—we have the essential difference between a dynamo and motor on which Prof. Ayrton and I have always insisted, and on which our theory depends.

After writing the above I received, as an invalid, the kind visit of Prof. Fitzgerald. He put the matter in another and more general way. "From the doctrine of reversibility, a good dynamo is a good motor, but this is on the assumption that the action is reversible. Now, sparking is a non-reversible action, and on this account alone there must be a difference between a dynamo and a motor."—Yours etc. JOHN PERRY.

10, Penywern Road, S.W., March 24, 1890.

MAPPING THE WASTE FIELD OF DYNAMOS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In my very hurried remarks on the last evening of the discussion of Messrs. Swinburne and Esson's Papers, I had no time to properly explain the diagrams which I then exhibited, and of which I have sent you photographs. I should, therefore, be glad if you would give me space to make one or two observations about them. The lines were produced by a series of impressions from a soft iron needle faced with india-rubber. The needle was, in the more satisfactory diagram, about half an inch long, three sixteenths wide, and about one-sixteenth thick. It was pivoted freely on a pin. The ends were pointed, and thus the impressions could be fitted heel to toe to form a continuous line. The line terminated when the field became so weak that the direction of the needle became uncertain.

The first object I had in making the experiment, which I was enabled to carry out by the courtesy of Messrs. Goolden and Co., and with the assistance of Mr. Vignoles, was to ascertain how far the assumptions made by Prof. Forbes in the three lemmas given by him in 1886 were consistent with what actually happens in practice. A secondary and interesting object was to produce evidence of the distortion due to cross magnetisation, described by Mr. Swinburne.

The machine with which the first three experiments were made was a Goolden-Trotter 2½ unit. A piece of cardboard was cut to fit the profile of the machine, and the field was excited with the normal shunt current of four amperes. The impressions of the rubber-faced iron needle were made starting at uniform distances of one inch apart on the upper pole-piece. Those that reached the lower pole-piece meet it at smaller intervals. This appears at first sight as though the magnetic potential was greater here, because one is accustomed to the apparent crowding together of the lines in a diagram produced by iron filings, but the density of the lines in these diagrams has not necessarily any connection with the magnetic potential. The crowding together of the lines is, I believe, due to the fact that the machine was placed on an iron bedplate, and this caused a distortion of the lines which did not primarily crowd them together, but produced a greater curvature in the lower half of each curve, and from the fact that each impression followed heel to toe they tended to crowd together on account of this increased curvature. The point is worth considering, and could be cleared up by further experiments.

The second and third experiments, in which the armature was held fast, for convenience, show the distortion very clearly. The fourth was to show the leakage in an extreme and complicated case, in which the great effect of the shaft, which runs in babbitted bearings, is very marked.

I hope at another time to supplement a complete map of the stray lines in two or more principal planes by lines of equal strength of field, by a snap coil and ballistic galvanometer. From the two series of curves thus found one should be able to find a certain line of force, which may be taken as the mean line, whose length is a measure of the fall of magnetic potential from one plane to the other, and should be comparable with this quantity, as calculated by Prof. Forbes' method.

I was induced to make these experiments, which I first carried out in 1884 or 1885, partly by noticing the imaginary and, I believe, somewhat incorrect lines of force drawn in Mr. Swinburne's diagrams. I have not mapped out the lines between the magnets and the shaft of an ordinary Gramme type dynamo, but from what I have seen of the behaviour of a needle there, they would be well worth examining.—Yours, &c., ALEXANDER P. TROTTER.

THE PFANNKUCHE ALTERNATOR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of February 21, 1890, I find a Note under the heading "An American Re-invention" (on page 387). If, according to said Note, the *Electrotechnishe Zeitschrift* has published a description of the "Pfannkuche Alternator," and used cuts belonging to the "Mordey Alternator," that does not, in my opinion, justify you in applying to my alternator the opprobrious appellation of "Re-invention." In the *Electrotechnische Anzeiger*, of Berlin, I some time ago stated my claims of priority, which can and will be duly enforced, as a patent has been granted to me in England; and I can prove that priority, if rushing into print and publication do not constitute priority of invention before the law. If Mr. Mordey is sure of his prior claims, let him come into our Patent Courts here, and we will soon see what his claims are worth. Your paper has the reputation for independence and fair-dealing, and I appeal to your sense of fairness to see that my interests and reputation are not damaged by uncontradicted statements from wrongly informed parties. Thanking you beforehand for publishing this notice at your earliest convenience,—I am, Yours, &c.,

GUSTAVE PFANNKUCHE.

Cleveland, Ohio, March 7, 1890.

FIXING MAGNETIC CURVES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The process described on page 488 of *The Electrician* of March 21, 1890, for fixing iron filing curves, quoted from *La Lumière Electrique* as the invention of M. Korobow, is by no means novel. It has been regularly used in the physical laboratory here for many years.—Yours, &c.,

W. W. HALDANE GEE.

The Owens College, Manchester, March 21, 1890.

LEGAL INTELLIGENCE.

Garman v. Brighton and Hove Electric Light Company.

This was an action heard yesterday (Thursday) in the Sheriffs' Court, Holborn, in which Emma Garman, of Brighton, sued the defendant Company to recover £1,000 as damages for the loss of her husband, who was killed by a shock from one of their wires. Mr. C. Chapman and Mr. Higgins were counsel appearing on behalf of the plaintiff; and Mr. Pike and Mr. Ruegg represented the defendants.

In opening the case, the learned counsel said that one of the Company's electric light wires was hung over the premises of Messrs. Abby and Hallett, brewers. The plaintiff's husband, T. H. Garman, was employed there as an engineer and night watchman. On the night of July 14, 1889, his duty required him to attend to a vat on the top of the building. A wire, it was admitted on the part of the defendant Company, was negligently hung in

Digitized by Google

a drooping condition, and the deceased accidentally touched it, and was killed on the spot. He (the learned counsel) asked the jury to award the widow and children fair and reasonable compensation.

Dr. LOWE deposed that he conducted the post-mortem examination on the deceased's body. He was astonished at the healthy condition of the man, who had evidently been struck by a wire containing over 2,000 volts of electricity. This was the immediate cause of death.

This evidence was objected to by Mr. Pike, although the defendant Company admitted that the wire was fully charged.

An actuary proved that calculating a man's life from insurance grounds, at the age of 32, and a weekly wage of 22s., the amount would be £1,090. 12s.

The Jury, after a short consultation, returned a verdict for the plaintiff, and awarded £800 as compensation: £200 for the widow, and £100 for each of the children.

Judgment was accordingly entered with costs.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning.*]

SPANISH TELEPHONES.—We notice in a French paper that tenders are invited for the installation and working of telephone exchanges at Burgos and Gerona. Particulars are not given as to whom the tenders are to be sent, but we presume to the leading public functionaries of these towns. Tenders have to be in, for Burgos by April 10, and for Gerona by April 11.

ELECTRIC TESTING STATIONS.—At the meeting of the London County Council on Tuesday, the tender of Messrs. Latimer Clark, Muirhead, and Co. was accepted for the supply of a gas-engine and dynamo for £453 10s., for the electric testing stations to be established in Cranbourne-street.

PLANT FOR SALE.—The Liverpool Electric Supply Company have completed their new central stations, and have a large surplus plant for disposal, consisting of Crompton, Siemens, and Brush dynamos, engines and boilers by Messrs. Marshall and Co., a Crossley gas engine, belting, cables, arc lamps, &c. Further particulars and prices can be obtained at the offices of the Company, 15, Highfield-street, Liverpool.

MESSRS. POOLE AND WHITE (LIMITED).—This firm, who recently commenced business at 58 and 59, Bread-street, London, E C., are now fairly settled in their commodious premises, where they have on show a choice selection of electric light fittings, globes and shades, switches, ceiling roses, &c., &c., many of which are of excellent design. The firm have on hand a number of choice original designs, which they will shortly include in their list. When the few remaining alterations are completed, Messrs. Poole and White will have one of the largest show-rooms in London, in the heart of the City. We understand that the firm are very busy, which indeed seems to be the case throughout the trade.

THE "AUDIO" TELEPHONE MOUTHPIECE.—This mouthpiece, known as the "Cotterell Whisperer," is now being generally introduced. It is specially designed for transmitters of the "Blake" type, but it is equally suitable for use on instruments of the "Gower-Bell" form. The "Audio" is easily fixed to the telephone by means of brass clips; when thus fixed conversation may be carried on in so low a tone that anyone in the same room as the person speaking is unable to hear the speaker's voice, while at the same time the conversation is carried over the circuit with perfect distinctness. The "Audio" is supplied by the Audio Telephone Mouthpiece Company, 15, Ann-street, City, Glasgow.

MESSRS. STANLEY, MORRISON AND CO.—We have received from this firm a circular giving prices and particulars of their various makes of india-rubber goods; and also of Morrison's special asbestos metallic rolled packing, &c.

SOUTH OF ENGLAND TELEPHONE COMPANY (LIMITED).—This Company are issuing a neat pocket guide to the public call offices in Lynn and Peterborough, also giving instructions how to use the telephone. Accompanying this is a list of the present subscribers to the King's Lynn Exchange, which shows very clearly the extension of the telephone in that part of the country.

THE PHONOGRAPH.—We are authorised to state that the reports which have been current in regard to the simplification of Edison's Phonograph by a person named Fossati are without foundation. They arose from the fact that a German gentleman visited Milan with one of Mr. Edison's latest machines—a much later pattern than has been generally introduced to the English public—and Mr. Fossati was merely indirectly interested in the exhibition of it. The galvano-plastic reproduction of cylinders mentioned in connection with Fossati has received the attention of Mr. Edison during many years, and in 1878-9 he invented a method of duplication of phonograph records by it.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

February 17, 1890.

2,527. O. CORNWELL. Brighton. Improved method for the regulation of the carbons in electric arc lamps by the expansion and contraction of metallic wires.

February 18, 1890.

2,578. J. R. FRASER, Preston, Lancs. A pocket electrical transmitting and receiving instrument.
2,621. H. G. WATEL. London. Improvements in electrically-driven fans.
2,653. S. Z. DE FERRANTI. London. Improvements in electric meters.
2,654. J. E. KINGSBURY. London. Improvements in the manufacture of electric cables (The Western Electric Company, United States).
2,655. J. E. KINGSBURY. London. Improvements in insulating electric wires (The Western Electric Company, United States).

February 19, 1890.

2,659. The Hon. C. A. PARSONS. Birmingham. Improvements in electric arc lamps for use in search light projectors and other purposes.
2,660. R. A. SCOTT. London. Improvements in lamp-holders or socket for incandescent electric lamps.
2,687. A. W. ARMSTRONG. London. The utilisation of a waste product for the means of producing electricity.
2,688. A. W. ARMSTRONG. London. Improvements in or connected with electric wire running and appliances therefor.
2,716. W. J. BREWAR. London. Improvements in the method of mounting by anti-friction gear electrical or other motors upon tramcars or other locomotives.

SPECIFICATIONS PUBLISHED.

1888.

17,163. RAWSON and WHITE. Electrical switches. (Price 8d.)

1889.

3,363. EDMUNDSON. Incandescent electric lamps. (Price 4d.)
3,424. SWINBURNE. Dynamo-electric machines, &c. (Price 8d.)
3,671. BOULT (Pouchard). Winding, &c., clocks by electricity. (Price 8d.)
4,845. FALKENSTEIN and others. Electric light fittings, &c. (Price 6d.)
5,066. NEWTON (Swan). Incandescent electric lamps. (Price 8d.)
5,976. LEYLAND. Electric alarm clock. (Price 8d.)
6,728. KAPP. Distributing electric energy. (Price 8d.)
6,745. KILIANI. Electrolysing substances in fusion. (Price 8d.)
7,127. VAUGHAN (Trott). Electric railways. (Price 8d.)
7,198. ADENEY and SAUNDERSON. Electric arc carbons. (Price 4d.)
7,600. CANT. Electric indicators. (Price 6d.)
7,947. FARQUHARSON. Dynamos. (Price 6d.)
8,459. WILLSON. Dynamo-electric machines, &c. (Price 11d.)

1890.

941. LINEFF AND BAYLEY. Electric tramways, &c. (Price 11d.)
950. THOMPSON. Dynamo machines. (Price 6d.)
1,028. THOMPSON (Gutmann). Converting a direct into an alternating electric current. (Price 8d.)
1,094. LAKE (Ewing). Secondary batteries. (Price 6d.)
1,106. CARPENTERS. Conduits for electric conductors. (Price 6d.)
1,110. HITCHCOCK (Burnley). Galvanic batteries. (Price 6d.)
1,329. BONNE (Thompson). Incandescent electric lamps. (Price 6d.)
1,345. BOSS. Stamp batteries. (Price 8d.)

Amended Specifications.—1884.

2,285. DORNFELD. Holders for incandescent electric lamps. (Price 8d.)

Reprint (with alterations).—1885.

12,984. DE BENARDOS and another. Working metals, &c., by electric currents. (Price 1s. 3d.)

Second Edition.—1879.

2,110. SIEMENS. Electric lighting. (Price 1s. 1d.)

Second Edition.—1888.

7,655. CROMPTON. Electric conductors. (Price 1s. 1d.)

COMPANIES' MEETINGS.

The Direct Spanish Telegraph Company (Limited).

The thirty-third ordinary general meeting of this Company was held at Winchester House, Old Broad-street, on the 24th inst., under the presidency of Sir James Anderson.

The MANAGER (Mr. Charles Gerhardi) read the notice calling the meeting and the minutes of the last meeting, which were confirmed by the present meeting, and signed as correct.

The report of the Directors was taken as read.

The CHAIRMAN said: Gentlemen, you will see by the report that we have earned £1,592 in excess of the amount realised in the corresponding period of last year. To earn this we have carried 17,260 more telegrams, or 155,192 more words, and I am pleased to observe that for this half-year under review there has not been any further decrease in the length of the messages; the average length is 10·48 words, and this condition has now continued for twelve months. There has been, ever since code-language and the word-tariff pure and simple (that is, a single word, which we can

Digitized by Google

only charge for) were introduced by the companies, a steady persistency on the part of the users of the cables to reduce the number of words in their telegrams, until at last we have reached the point at which 35 per cent. are below five words; and the average is, as I have already said, 10·48 words. The companies do not complain at the reasonable endeavour on the part of the telegraphing community to reduce their expenses for telegrams; but we own freely that the compilers of codes have so brooded over the subject, and worked out all the combinations and possibilities of code-language, that the result has greatly exceeded the economic possibilities that we considered possible when we agitated at the different Conferences for the adoption of code-language and the word-rate pure and simple. Were the reduction in the length of telegrams to stop where it now is, we might take comfort from the fact that merchants can now use the telegraph for small transactions—for business that may come to nothing, and for inquiries that lead to no profitable result. We might expect that telegraphy would continue to grow. The growth of telegraphy is no doubt due to such causes amongst many others. It is now cheap enough to admit of the smallest transactions being carried out by telegraph. The result of that is that we find in practice that when merchants abroad, brokers, and others, see a ship coming in or hear of business, they send a word off—a small telegram—to their correspondents, asking to be permitted to do some transaction. This is a phase of business which could not be done if the tariff were high. Therefore, we do not look with horror on cheap telegraphy, especially where there is a large community likely to use it. That is one of the advantages we have in dealing with a Continental State like Spain, which seems to be growing in commercial transactions, and more alive to commerce than it used to be. We therefore need not despair as to the traffic continuing to grow. Unfortunately, whenever there is a reduction of tariff there is a loss to begin with, in some important instances a prolonged loss, which is disappointing, and very different from the result we were encouraged to expect by the reduction of tariff. In the case of this Company, we are now working at a tariff so low that we have a right to expect that we had established a minimum charge; but we are not so sure of this as we would like to be, as we know that at the coming Telegraph Conference to be held in May of this year there are some new terrors proposed, and some administrations look with an unfriendly eye upon our poor 4½d. per word. Happily there are other telegraph administrations which consider this game of reduction has gone too far, as the great majority of the European States are losing money on their telegraph service, and they do not like it. I am not telling you all this without some point. I am supposing that some of you have examined the balance-sheet and have noticed that we are carrying forward a sum unusually large for this Company; and that to earn this £1,592, and transmit 155,192 more words, our expenses have increased by £690, not all due to salaries, but some of it to the increased rent and taxes for larger premises, more stationery, more printing, more new instruments and improvements at our stations; also there is the rent for the unexpired lease of the old office in Leadenhall-street, which will not recur; but after all that is said, we are paying you 6 per cent. and carrying forward a fair sum of £846. 18s. 2d.; and your Directors desire to cling to this sum not only because the action of the Conference may still further affect our revenue, but also for another reason. Should our prosperity continue, we shall act prudently if we look forward to a greater or lesser amount of special reserve for the reduction of our Debenture debt. This we consider due to our Preference shareholders. You know we have £62,000 of Debentures at 6 per cent.; and some plan ought to be adopted, when they are due in 1894, to deal with them, either by a special reserve, or by calling up the £1 per share still uncalled, or by an increase of ordinary capital, which may be issued at a premium if we continue fortunate, or the Debentures may be renewed at a lower rate of interest if our reserve is as good as we hope it will be when the time comes. These are points before your Board affecting the policy they may desire to adopt as time goes on. I hope, then, you will consider that so long as we pay a 6 per cent. dividend we are only acting prudently in laying by as much more money as we earn above that 6 per cent. I sincerely hope we may continue to receive that 6 per cent.; but I by no means pledge myself to any opinion. We may have another interruption of our cable. We do not know what proposals may be made by the Telegraph Conference (some of them may hurt us or may not), and we feel that 6 per cent. is as much as we ought to divide for the present. I am happy to be able to state that France has given us the use of a direct special wire between the Paris Bourse and our Marseilles office, so that the transmission of our telegrams to and from Barcelona is much accelerated, and our traffic in consequence has increased. Spain has also given us a good wire from Bilbao to Madrid, and our traffic is at present increasing, and our new office in Gracechurch-street is realising our anticipations. I have before me all the items upon which there has been any increase of expenditure, should any honourable proprietor care to ask for further information. Unless you ask me questions I think I have said all that can be usefully said. I move—

"*That the report and accounts now presented be and they are hereby received and adopted.*"

Mr. E. ETLINGER seconded the motion.

The CHAIRMAN invited discussion, but no shareholder rising to address the meeting, he put the resolution, which was carried unanimously. He then proposed:—

"*That the dividend at the rate of 10 per cent. per annum, less income-tax, on the Preference shares, and a dividend at the rate of 6 per cent. per annum on the Ordinary shares, free of income-tax, both for the half-year ended December 31, 1889, be and are hereby declared.*"

Mr. ETLINGER seconded the motion, which was carried unanimously.

On the motion of the CHAIRMAN, seconded by Mr. J. DENISON PENDER, Mr. E. Etlinger was re-elected a Director; as was also Mr. J. Denison Pender, on the motion of the CHAIRMAN, seconded by Mr. ETLINGER.

Mr. WALTER BARNETT then proposed the re-election as auditor of Mr. Herbert R. Duke, with a remuneration of twenty guineas. That was an increase of Mr. Duke's remuneration; and he thought it was justified, having regard to the fact of the increased prosperity of the Company, and consequently, as he would suppose, of his augmented work.

Mr. DYETT seconded the motion, which was carried unanimously.

Mr. DUKE acknowledged his re-election, and said that when he first became auditor, on the death of the late auditor eight or ten years ago, the accounts were not so voluminous as they were at present. He was very much obliged to the shareholders for the increase in his remuneration. The work of auditing the accounts took himself and a clerk the best part of a week twice a year. He congratulated them on the satisfactory report which had been presented that day.

Mr. LOWE then proposed the following resolution:—

"*That in the opinion of this meeting the Directors' remuneration should be now increased beyond the sum of £400 per annum, and that in view of their declared intention not to avail themselves of their rights under the 71st of the Company's Articles of Association as it now stands, the Directors be and are hereby requested to give notice of a special resolution being brought forward at the next half-yearly meeting for altering Article 71 so as to increase their remuneration to £600 or otherwise, as may from time to time be voted in general meeting.*"

Mr. BARNETT seconded the resolution.

The SOLICITOR (Mr. Blunt): The Articles of Association prescribed that the Directors should receive £400 a year, with an additional sum of £100 for each 1 per cent. dividend paid to the shareholders above 6 per cent. It is understood, apparently, by the terms of the resolution, that the Directors do not desire to avail themselves of that power. I believe that they have been influenced by the fact that the shares are not of the same magnitude as they were when that Article was written, and 6 per cent. is paid on a lower capital than when the Article was introduced. I understand that in consequence of that this resolution is proposed as, in point of fact, an alteration of this Article; and, as most gentlemen present are aware, an Article cannot be altered without a special resolution; that requires special notice, and I understand that this resolution is a request to the Board to bring forward a resolution at the next half-yearly meeting dealing with this matter.

Mr. COCHRAN inquired whether the altered circumstances of the Company made any alteration in the Articles of Association necessary.

The SOLICITOR replied that as a matter of law he would say that the Articles still held good, and therefore the Directors would be entitled, on paying an increased dividend of 1 per cent., even on the reduced capital, to the extra remuneration mentioned in the Article; but their feeling was that they would rather leave the fixing of the remuneration above £400 to the meetings from time to time.

The CHAIRMAN having read the resolution again,

A SHAREHOLDER asked, "What does 'otherwise' mean?"

The SOLICITOR: It leaves power to the general meetings to alter the remuneration from time to time.

The CHAIRMAN: Even to reduce it?

The SOLICITOR: Even to reduce it.

Mr. DYETT inquired whether what was proposed would be an increase or a decrease on what the Directors were entitled to.

The CHAIRMAN: An increase. We should have been entitled to that last year according to our lawyer's opinion, but we want to see what will happen. We are not very eager about it. By next October we shall know something more than we do now. He then put the resolution, which was carried unanimously.

Mr. JOHN NEWTON proposed a vote of thanks to the Chairman and Directors for the satisfactory position to which they had brought the Company. He was very pleased to hear that the next Telegraph Conference was going to be held so soon, for he was one that liked to be out of his misery at once. The telegraph shareholders looked forward to this Conference with something like fear, and he was glad to hear that at the next Conference there would be representatives who thoroughly understood the position of telegraph companies, not only here but on the Continent. He would not, however, like the representatives at the Conference, to express the opinion which the Chairman had expressed, that coding had reached its perfection, because he did not think that the users of the telegraph had reached the full power of taking advantage of telegraphic communication. Telegraphing was now done so cheaply, and the more cheaply it could be done the more business they would have. It was to his mind impossible to say that it would not be within the reach of merchants to telegraph cheaper than they did now, by means of codification. He had had a great deal of experience in seeing the development of the coding system. He remembered the very early days, when it was scarcely possible to express fully what was required in twenty words, but at the present time they could express in three or four words as much as a few years ago they could convey in twenty words.

Mr. DYETT seconded the motion, which was carried unanimously.

The CHAIRMAN: I may say a few words more about the coding question. I may tell you that we have now got to this point, that we make about a halfpenny a word net from a telegram. If you come to reduce that you will see that it is a new terror to us. All the Continental States who have low tariffs are losing money. Fourteen of them are losing money, and only six are making a fraction above their expenses. It is all very well when you can tax people to cover a deficit, or when you can make it appear, by fusing the Telegraph and Postal services together, that you are making a general profit. We, however, in these companies cannot tax anyone. We are working very low. The average number of plain words conveyed by each code word is 8 or 10, so that the tariff is really for 8 or 10 words that merchants are charged. We do not complain, however, because we introduced this system; but you may go too

Digitized by Google

far. As it is, at the forthcoming Conference one State proposes a minimum of five words, and another proposes ten words; so you see they are feeling it. Another State proposes that a double charge should be made for coding messages. We are not in favour of the latter. We have met frequently, and have thrashed out everything that has been proposed by the different States. We shall go to the Conference primed with knowledge, but what will happen at it we cannot say, as side issues arise. We never know what may happen, therefore I am always glad when these Conferences are over, and we have again five years' peace. I hope when we meet next October I may be able to speak cheerfully about the Conference.

The proceedings then terminated.

The Telephone Company of Egypt (Limited).

The seventh ordinary annual general meeting of the shareholders in this Company was held on Tuesday at the offices, 14, Austinfriars, London, E.C., under the presidency of General Alexander Fraser, C.B., R.E.

The SECRETARY (Mr. A. B. Chalmers) having read the notice calling the meeting,

The CHAIRMAN said: Gentlemen, I do not think I have much to add to what is stated in the report of the Directors. As you are aware, we are now established in five places in Egypt, viz., in Alexandria, Cairo, Mansourah, Zagazig, and Port Said; and we hope soon to be able to increase the number of installations. We are now in negotiation with the Government to endeavour to establish one at Assiout. I am happy to say with reference to our Port Said installation that it has been very energetically established by our manager. We have been able, by the help of our colleague, Mr. Grewing, to see Sir Rivers Wilson, and to secure his co-operation in obtaining from the Suez Canal Company permission to place a cable across the Canal to give telephonic communication with the other side of the waterway. The Company has also given us a subscription, and this will not only enable us to increase our subscribers at Port Said, but possibly at other places on the Canal up to Suez. Since we last had the pleasure of meeting you we have lost one member of our Consultative Committee in Egypt in the person of Mr. Chapman, who was agent of the Peninsular and Oriental Company, and who resigned on his return to this country. In our report we have said that we do not expect a great development of business at Cairo and Alexandria for the present; but I think myself that when the prosperity of Egypt increases, our business in telephones will also increase. With reference to the resignation of Mr. Chapman from the Consultative Committee, we have thought it well to appoint a gentleman as a member of the Committee who has been very useful to us, Mr. A. J. Manuk, and since his appointment he has been very useful to us in our relations with the Government and their functionaries. I do not think there is anything more for me to say in the matter. I should like to remark that our business in Egypt has been very ably carried on by our manager, Mr. Evans, who has proved himself, I think, to be thoroughly up to the work, and conducts the business which his late father carried on with all the energy and ability of a young man. We have at Cairo also in the person of Mr. Begni an able and satisfactory manager. I think the shareholders are quite justified in giving their thanks to these gentlemen and the staff in general in Egypt. The work has been carried on in London, too, by Mr. Chalmers and staff in a very satisfactory manner. Unless you have any questions to ask I beg to move:—

"*That the report of the Directors and statement of accounts be and they are hereby received and adopted, and that a dividend be paid of 6 per cent. on the Preference shares, free of income-tax.*"

Mr. HENRY GREWING seconded the motion, which was agreed to.

On the motion of the CHAIRMAN, seconded by Mr. GREWING, the retiring Director, Mr. Thos. Lloyd, was re-elected to his seat at the Board.

The Auditors, Messrs. Price, Waterhouse and Company, having been also re-appointed,

A vote of thanks to the Chairman and Directors was passed, and the proceedings terminated.

Newcastle and District Electric Lighting Company (Limited).

The second annual meeting of this Company was held on the 19th inst., at the Crown Hotel, Clayton-street, Newcastle.

Mr. J. D. Milburn presided; and there were also present, Sir Benjamin Browne, the Hon. C. A. Parsons, Mr. H. C. Harvey, Mr. J. B. Simpson, Mr. F. J. Snowball, and Mr. J. Patterson (secretary).

The following report of the Directors was taken as read:—The Directors have to report that the Company's central electricity supply station is now in full working order, and that up to the present arc and incandescent lamps equivalent to 2,100 ten candle-power lights have been connected to the mains of the Company, and the work is proceeding for switching on further lamps, equivalent to 3,500 ten candle-power lights. The Directors anticipate that in a very short time the Company will have sufficient business to take up all the electric current which the present plant is capable of supplying. The delay in receiving the Board of Trade licence for the Company to proceed has been got over by the Directors being able to come to a private arrangement. It is as yet too early to give an accurate forecast of the financial prospects of the Company, but the Directors have no reason to alter the favourable opinion as to the future of the Company that they have always held.

The CHAIRMAN, in moving the adoption of the above report, referred to the difficulty which arose in consequence of a technical error in the draft Board of Trade licence at the moment that the licence should have been handed to the Company. He said that after waiting several weeks the Directors resolved to appeal to the Mayor and Corporation for leave to lay down their mains pending the receipt of the licence from the Board of Trade. The Corporation considerately granted the Company's request under certain conditions, and every effort was put forth by all connected with the working of the Company to make up for lost time. In order to minimise the inconvenience to the public through the lifting of the flags and crossings, an arrangement had been made between that Company and the Newcastle Electric Supply Company for the division of the town into two areas, with the exception of the Quayside, which was to be open to both companies. As regarded prospects, business was flowing in steadily. The total number of 10 candle-power lamps which could be efficiently connected to the Company's stations, as at present completed, would be about 9,000, and of these probably not more than 6,000 or 7,000 would be simultaneously in use, thus leaving one generating machine and boiler always in reserve. Up to the present the Company had connected with their mains 41 installations, representing from 3,000 to 4,000 10 candle-power lamps, and orders for current have been given for about 1,500 or 2,500 more, and many others were in prospect. It would appear, therefore, that the Company would shortly have more business than it could manage without increasing its generating power, and very shortly it might be necessary to expend more capital to make such increase. Owing to the special system of the plant and machinery, that could be done gradually. When selecting the generating station the Company took care to secure a building of such capacity as would allow the increase of plant to any degree likely to be demanded by future requirements. The present building at Forth Banks would permit of the generating plant being doubled, and the Company had the option of acquiring the building adjacent thereto. Including this second building, the Company would have space for generating-plant equal to eight or ten times its present productive power, which would represent something like the simultaneous running of 50,000 or 70,000 lamps installed. Their Managing Director, the Hon. C. A. Parsons, had recently been experimenting with arc-lighting in conjunction

PATENT
SILICIUM BRONZE AND SILICIUM COPPER WIRE.
The best for overhead Telephone and Telegraph Lines,
AND ALL ELECTRICAL PURPOSES.
Hard Drawn High Conductivity Copper Wire.
ROLLED AND DRAWN
PHOSPHOR BRONZE.
PHOSPHOR BRONZE
VULCAN PHOSPHOR
DURO METAL
PHOSPHOR BRONZE
BEARINGS, BUSHES,
AND OTHER PARTS OF
ELECTRICAL MACHINERY.
SOLE PROPRIETORS of the British, Indian and Colonial Patents,
THE PHOSPHOR BRONZE COMPANY (Limited),
87, Sumner Street, Southwark, London, S.E.
WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

Digitized by Google

with the alternating-current system, which was the system adopted by the Company. Large arc-lights at the Tyne Theatre, the Company's offices, and the generating station had been very successful, and the Directors believed they would be enabled to undertake at an early date a portion of the lighting of the city streets where brilliant illumination was desired. Presently they might look forward to getting some use for their current during the daytime. In America electricity was becoming quite the fashion for motors of every description, lifts in hotels, overhead railways, printing presses, &c., and that Company meant to encourage its application to some of those uses to the utmost extent. But it was to the tramways that they must turn their anxious attention. He believed that the Directors of the Tramway Company would not remain long in the background so soon as a reliable and profitable scheme for electric traction could be indicated to them. Last year, in announcing the policy intended to be pursued by the Directors of that Company, he said that there was no intention to enter into any insane competition or death-grapple with gas. It would be some time yet before electricity would vie in cheapness with gas. With arc-lighting it was different. There was no doubt that the electric light would cause an increased use of gas in the city, for the brilliancy of the illumination secured by those who used it would cause the users of gas to use much more of that illuminant. He believed that shortly the fire insurance offices would look upon houses lighted by electricity as the safest of their risks. In conclusion, the Chairman stated that the light had given entire satisfaction, and the Company had not had a single complaint.

Sir BENJAMIN BROWNE seconded the motion. He thought the electric light was very popular.

The report was adopted.

Sir B. C. Browne and Mr. A. F. Wade, retiring Directors, were re-elected; and Messrs. Strachan, Hill, and Co. were re-elected auditors.

The meeting then terminated.

NEW COMPANIES REGISTERED.

DURAND ELECTRIC, PETROLEUM AND GAS ENGINE, AND MANUFACTURING COMPANY.—Objects: To take over and carry on as a going concern the business of Eugene Durand, at 163, Avenue Victor Hugo, at Paris, and elsewhere, and acquire and work patents and inventions, belonging to and connected with or for the purposes of the said business, the exact nature of which is not specified in the Memorandum of Association. Capital £100,000, in £10 shares. Registered March 15th, without Articles of Association, by Henry Martin Green, solicitor, Havant, Hants.

ELECTRIC METER COMPANY.—Objects: To carry on the trades or businesses of electricians, mechanical engineers, and manufacturers, and to purchase and carry into effect certain letters patent relating to electric meters and other rights and things, entering therefor into an agreement with the Corporate Trust, Limited, (incorporated August 30, 1889, with a capital of £50,000 in £10 shares), the particulars of which are not specified in the Articles of Association. Capital, £50,000, in £10 shares. Borrowing powers unrestricted. Registered, March 22nd, by Walter Webb and Co., solicitors, 23, Queen Victoria-street.

CITY NOTES, &c.

AMERICAN BELL TELEPHONE COMPANY.—The statement of this Company for the past year shows a net increase of $247,683, and a surplus after payment of dividend and all charges of $122,975, the total surplus being $2,151,011.

ANGLO-PORTUGUESE TELEPHONE COMPANY.—An interim dividend at the rate of 4 per cent. per annum (less income tax) has been declared upon the share capital of this Company.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The receipts of this Company for the week ended March 21st amounted to £5,176.

EASTERN TELEGRAPH COMPANY (LIMITED).—This Company announce the payment on April 15th next of interest of 3s. per share, less income tax, being at the rate of 6 per cent. per annum on the Preference shares of the Company, for the quarter ended March 31st current, and the usual interim dividend of 2s. 6d. per share on the ordinary shares, free of income tax, in respect of profits for the quarter ended December 31, 1889. The register of transfers will be closed from April 8th to 15th next, both days inclusive.

EASTERN EXTENSION TELEGRAPH COMPANY.—The accounts of this Company to December 31st show, subject to audit, a balance of profit of £139,744, after payment of three interim dividends. The Directors now propose to distribute on the 23rd prox. a dividend of 2s. 6d. per share, making a total dividend of 5 per cent. for the year 1889. It is proposed to pay a bonus of 4s. per share, equalling 2 per cent., making a total distribution of 7 per cent. for the past year. The balance of £58,494 has been carried to the reserve fund, which now stands at £710,113. The register will be closed from the 16th to the 23rd prox. inclusive.

ELMORE'S WIRE MANUFACTURING COMPANY (LIMITED).—This Company was put upon the market last week, subscriptions being invited for 100,000 Ordinary shares of £2 each at a premium of £1 per share. The total capital of the Company is £300,020, divided into 150,000 Ordinary shares of £1 each and ten Founders' shares of £2 each. Half of the premium on the shares now issued is to be carried to a reserve fund, and the remainder is to be paid to Elmore's Patent Copper Depositing Company (Limited). The Board includes five Directors of this last-named Company, who will join after allotment, one of the other Directors being Mr. William Elmore. The Company expect to receive large orders for wire for electrical purposes in connection with telegraphic and cable services and central lighting stations, and claim for its process many advantages over existing processes. The purchase-money to be paid by the new Company to Elmore's Patent Copper Depositing Company (Limited) is £75,000, half the amount of the premiums (as stated above), and the allotment of the ten Founders' shares of £2 each, which are to receive no dividend until 20 per cent. has been paid upon the Ordinary shares in any year, after which the surplus profits will be divided, as to one moiety, between the holders of the Ordinary shares, and, as to the other moiety, between the holders of the Founders' shares. The list opens this day (Friday) and closes on or before to-morrow (Saturday). Objects: To carry on the business of metallurgists and makers of and dealers in metals, and metallic alloys, and particularly to acquire from Elmore's Patent Copper Depositing Company (Limited), under an agreement, patent rights and privileges, and to carry the same into effect. Letters of allotment and regret were posted this week.

GLOBE TELEGRAPH AND TRUST COMPANY.—The Board of this Company notify an interim dividend of 2s. per share, payable on the 18th proximo.

NOTTING HILL ELECTRIC LIGHTING COMPANY (LIMITED).—This Company notify that share certificates are now ready, and can be exchanged for the banker's receipts for amounts paid on application, allotment, and first call.

SCHOOLING AND CO. (LIMITED).—The Directors of this Company have declared a dividend of 5 per cent. for the last six months, making, with the interim distribution, 10 per cent. for the past year.

STOCK EXCHANGE.—The Committee have appointed Wednesday, April 9th, as special settling day for the following securities, which are also ordered to be quoted in the official list:—Crompton and Co. (Limited), Preference Shares Nos. 1 to 20,000; United River Plate Telephone Company (Limited), £146,128 Five per Cent. Debenture Stock (part of £200,000 authorised); Westminster Electric Supply Corporation (Limited), Ordinary Shares Nos. 101 to 42,953.

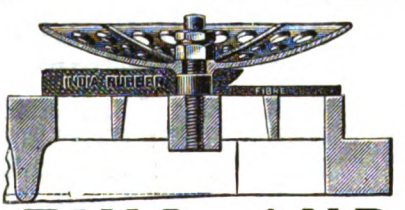
VICTORIAN SCHANSCHIEFF ELECTRIC LIGHT AND POWER COMPANY.—The *Melbourne Argus* reports that this Company has gone into liquidation.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY, LIMITED.—The traffic receipts of this Company for the week ended March 21st, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,991.

WESTMINSTER ELECTRIC SUPPLY CORPORATION (LIMITED).—Lord Suffield (the Chairman) presided on Wednesday at a confirmatory meeting of the shareholders, held at the offices, 4, Victoria-mansions, S.W., which was called for the purpose of approving of certain resolutions proposed at a previous meeting, altering one or two of the Article of Association. The Chairman having formally submitted the resolutions, they were unanimously adopted.

NEW VALVE

No Rubber, Percha, or Leather.



One-half the price of Rubber or Metal.

FOR CIRCULATING AND AIR PUMPS.

Unaffected by any Lubricating Oils. Does not Expand in diameter. Feed Water may be worked at any temperature Suitable for any shaped guards. Only one quality manufactured.

"12, John-street, Sunderland, 26th Sept. 1885.

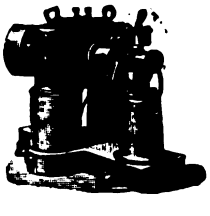
"DEAR SIRS,—In reply to your letter of the 25th inst., the Valves I got from you have done their work well, and ARE AN UNQUALIFIED SUCCESS. I will continue to get them from you as required.—Yours faithfully, JAMES WESTOLL."

For further Testimony and Prices, apply to MOSSES & MITCHELL, 68-71, Chiswell Street, London.

Digitized by Google

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Wednesday, March 26, 1890.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending March 26, 1890. Highest.	Lowest.
£			**TELEGRAPHS.**		£ s. d.			
1,770,360	Stock	15/0	Anglo-American	49 50	5 10 0	Jan., Apr., July, Oct.	50	...
2,614,320	Stock	30/0	Do. Preferred	83 84	6 10 11	,, ,,	84	83
2,614,320	Stock	...	Do. Deferred	14½ 14⅝	...	February	14½	...
130,000	£10	3/0	Brazilian Submarine	12⅝ 13	5 15 5	Mar., June, Oct., Dec.	12⅞	12½
112,900	£100	5%	Do. 5 per Cent. Bonds	100 102	4 18 0	January and July	...	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	104 107	4 13 6	June and December.	...	...
16,000	10	9/0	Cuba Submarine	11 11½	7 16 6	February and August	11⅝	11 1/16
6,000	10	10%	Do. Preference 10%	17½ 18½	5 8 1	,, ,,	...	...
12,931	5	2/6	Direct Spanish (£4 paid)	4 4½	4 8 11	March & September	...	...
6,000	5	10%	Do. Preference 10%	9 10	5 0 0	April and October	...	...
60,710	20	3/6	Direct United States	10⅛ 10⅜	6 15 0	Jan., Apr., July, Oct.	10⅜	10¼
380,000	10	2/6	Eastern	14 14½	4 11 3	,, ,,	14½	14
70,000	10	6%	Do. 6 per Cent. Preference	14⅞ 15⅛	3 18 8	,, ,,	14⅜	...
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock	106 108	3 14 1	May and November.	108	108⅞
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	106 109	4 11 9	February & August	107½	107
250,000	10	2/6	Eastern Extension	14 14¼	4 11 3	Jan., Apr., July, Oct.	14⅛	14 1/16
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	100 102	5 17 8	February & August	101	...
473,000	100	5%	Do. 5 per Ct. (Austrln. Gov. Sub.) Debs. 1900	102 105	4 15 3	January and July	104½	...
179,177	10	1/9	Globe Telegraph and Trust	8⅝ 8⅞	6 1 1	Jan., Apr., July, Oct.	8⅞	8½
178,992	10	6%	Do. 6 per Cent. Preference	14⅜ 14⅝	4 0 8	,, ,,	14 3/16	14 1/16
150,000	10	5/0	Great Northern	15 1/16 16	4 13 9	Jan., July, and April	...	...
17,000	25	12/6	Indo-European	41 43	5 16 3	April and October	...	...
9,000	8	4/0	Reuter's	7 7½	5 6 5	April and October	...	...
15,609	10	3/6	West African Telegraph	9½ 10⅜	...	...	...	...
300,000	100	5%	Do. 5 per Cent. Debentures	98 101	4 19 0	March & September	100½	98¼
80,000	10	5/0	West Coast of America	10¼ 10⅜	5 11 4	January and July	...	...
150,000	100	8%	Do. Debentures 8%	121 126	6 7 0	June and December	125½	...
88,321	10	nil.	West India and Panama	3½ 3¾	...	...	3 1/16	3⅛
34,563	10	12/0	Do. 1st Preference 6%	11½ 12	...	April and October	12 1/16	11⅝
4,669	10	10/0	Do. 6 per Cent. 2nd Preference	14½ 15½	...	...	15	14¼
45,181	15	6/0	Western Brazilian	10½ 10⅝	6 19 8	May & November	10⅝	10 1/16
$1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	122 126	5 11 1	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	99 101	5 18 10	March & September	...	...
			TELEPHONES.					
224,850	14/0	5%	Consolidated Telephone and Maintenance	1/16 1⅛	5 12 0	Yearly	...	...
220,000	£1	3%	Oriental (11s. paid)	1/16 1/16	3 5 11	...	...	...
80,000	5	3/0	National	5 5½	...	June and December.	5⅜	5⅛
55,000	5	2/0	United River Plate	4½ 5	...	January and July	...	...
			ELECTRIC LIGHT.					
409,000	10	...	Electric Construction	10⅛ 10⅜	...	...	...	...
555,000	5	...	London Electric Supply	2⅜ 2⅝	...	...	...	...
500,000	10	...	Metropolitan Electric Supply (£6 paid)	5⅛ 6	...	...	5⅞	5⅞
79,934	5	6%	Swan United (£3. 10s. paid)	4⅜ 5⅛	4 0 0	...	...	...
			MISCELLANEOUS.					
37,350	12	12/0	Telegraph Construction and Maintenance	43 45	5 6 8	March and July	44⅜	43½
41,600	10	10/0	India Rubber, Gutta Percha & Telegraph Works	17½ 18½	5 8 1	February & August	18½	17⅞



Before Ordering!

ELECTRICAL PLANT & ACCESSORIES

(Statter's) WRITE FOR THE FOLLOWING PAMPHLETS TO THE (United)

ELECTRICAL ENGINEERING CORPORATION, Ld.

PLANT WORKS: WEST DRAYTON, near LONDON.
FITTINGS WORKS: ALBERT WORKS, 36, ALBERT EMBANKMENT, S.E.
LONDON OFFICES: 3, PRINCES MANSIONS, VICTORIA STREET, WESTMINSTER.

"ELECTRICAL DISTRIBUTION."—Commercially considered, with Estimates.

"MACHINE DRIVING BY ELECTRICITY."—The Uses of Electro-Motors for Traction and Stationary Purposes.

"THE TELPHER SYSTEM OF CHEAP TRANSPORT," for Minerals, Goods and Passengers.

"ELECTRICAL SUPPLIES."—Prices and Particulars of the most approved Electrical Appliances

ELECTRICAL PLANT ON VIEW.

Digitized by Google

THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 620.—Vol. XXIV. FRIDAY, APRIL 4, 1890. Price Fourpence.

NOTES.

The interesting Paper read last week at the Institution of Electrical Engineers by Dr. Harries and Mr. Newman Lawrence evoked considerable comment, and will probably give rise to still more. The results brought forward by the authors of the Paper are, it is true, by no means new. It has long been known that the resistance of the human body to alternating currents is considerably lower than its resistance to continuous currents. It has also been the painful personal experience of most electricians that the "shocking" properties of an alternating current are decidedly superior to those of a continuous current; although in this respect the palm is awarded by many to the current from a Brush arc-light machine. The interest of the Paper lies, however, in the fact that it is a plain statement of the results of a painstaking and impartial investigation of a subject in which accuracy and impartiality have hitherto been conspicuously lacking. Considering, however, the wide difference between the conditions which obtained even in the experiments in Table E, and those which are likely to obtain in the case of accidental contact with electric light wires, the deduction of such a formidable looking "danger ratio" was, we think, hardly warranted. As we remarked in connection with the nauseating experiments of Mr. Harold P. Brown and others, the question at issue, so far as electrical engineers and the public are concerned, is a very straightforward one. It is simply whether the dangers of high-tension alternating currents so far outweigh their advantages that they ought to be absolutely prohibited. With ordinary care and good workmanship the "danger ratio" may be made to very closely approximate unity.

The statements made by Mr. J. S. Forbes at the meeting of the shareholders of the London Electric Supply Corporation on Monday last, together with Mr. Ferranti's report, render the present position of affairs at Deptford tolerably clear. Two 30,000-light dynamos working at one-quarter their proper voltage are, it must be confessed, a most discouraging result after two years' hard work and an expenditure on plant and machinery alone of over £68,000. But the building of a colossal generating station at a great distance from the centre of supply, the employment of abnormally high pressures and of abnormally big dynamos, all tend to make the Deptford scheme, although grandiose in conception, an enterprise, to quote the Chairman's words, "involving a great many speculative quantities and something also risky." That the many difficulties which are now being encountered by Mr. Ferranti may be triumphantly overcome is, we are sure, the wish of electrical engineers all over the world. Meanwhile there is nothing for it but to exercise that patience so frequently recommended by the Chairman in the course of his long and somewhat disconsolate speech, and to trust the confident tone still assumed by Mr. Ferranti will be more justified by the successes of the future than it is by the events of the past.

Some interesting facts with regard to the magnitude of the Corporation's operations may be gathered from the accounts, which, as last year, are models of clearness. The total expenditure of the past two years amounts to £505,258, of which no less than £102,728 have been absorbed in buildings, and £68,342 in plant and machinery. Mains during 1888-89 figure for £44,307, converters for £26,632, and meters for £1,682, while the cost of the Provisional Order was close upon £4,500. The sale of current brought in £25,871; and this, together with other extraneous sources of revenue, enabled the Corporation to pay a dividend on its Preference shares and carry forward a small sum.

We gather from Patent No. 3,424 of last year some further particulars of Mr. Swinburne's device of reversing pole-pieces for obviating the necessity of changing the lead of a dynamo as the load alters. The subsidiary armature core consists of a ring of wire or discs. Each commutator connection passes only once over the outside of the core, and is either made thin where it passes through the reversing field, or is embedded within a groove milled in the core, so that the reversing pole pieces may be brought very close to the armature core. The reversing magnets are adjustable in position like the brushes, and are excited by the main current, and their influence consequently increases with the load.

In the same specification several devices are described for decreasing the excitation of the field-magnets of a synchronous alternate-current motor as the load is increased. In order to obtain self-excitation, and to prevent sparking, Mr. Swinburne proposes an exceedingly complicated method of exciting the field-magnets. This consists of two subsidiary armatures and commutators, so arranged as to give alternating currents differing in phase by a quarter of a period. These currents, when

Digitized by Google

rectified by the commutators, give a fairly constant exciting current round the field-magnets. In order still further to prevent fluctuation, it is ingeniously proposed to simply surround the field-magnets with a short-circuited coil, the induced currents in which will necessarily tend to hinder change in the number of lines of force, and will thus diminish sparking. We have recently described (*The Electrician*, March 7th, p. 452), a device due to Zipernowsky, Déri, and Bláthy for accomplishing the same object by somewhat similar means.

Dr. Moser, whose experiments on the electrical resistance of highly rarefied air we have recently described (*The Electrician*, March 14th, page 471), has been investigating whether there is any measurable difference in the specific inductive capacity of air in the various states of rarefaction he has worked with. Apparently he expected to find great changes, for his methods of measurement are not very sensitive. The differences found by Boltzmann, Ayrton, and Perry for the dielectric constants of vacuum, air, and the common gases, did not amount to more than about 6 parts in 10,000. Rarefied air would, presumably, have a specific inductive capacity intermediate between those for ordinary air and vacuum, and the variation in its amount would be far too small to be distinguished with such apparatus as Dr. Moser employed. His failure to find any alteration does not therefore prove anything.

The curious influence of magnetization on the electrical conductivity of iron, nickel, and cobalt, has recently formed the subject of a research by M. Goldhammer. Plates of the different magnetic metals were placed parallel or perpendicular to the lines of force produced by a large electro-magnet, and the resistance of them was measured by a Wheatstone Bridge. For bismuth the percentage variation was found to be proportional to the square of the magnetising force, and also to the square of the magnetisation; since, for this metal, there is a constant ratio between the two. The greatest variation took place perpendicular to the lines. For nickel and cobalt the resistance increases in the direction of the lines, and decreases in the perpendicular direction, the variation being independent of the sign of H, the magnetising force. The percentage variation tends rapidly to a maximum as H increases, and attains it sooner for cobalt than for nickel; and since the curve connecting the two is very much like the curve connecting H with the intensity of magnetisation, the author assumes that the variation, as in the case of bismuth, is proportional to the square of the magnetisation. M. Goldhammer concludes from his experiments, and from some due to M. Du Bois, that in a magnetic field the physical properties of metals undergo modifications dependent on the direction of the lines of force. If these alterations are reversed with the reversal of the lines they vary directly as the magnetic intensity, while, if they are unchanged by the reversal, they are proportional to the square of the magnetic intensity.

The opposition of the Bath Gas Company to Mr. Massingham's electric lighting scheme still continues. Not content with having induced the Board of Trade to send down Major Cardew to inspect the underground main work, and with a similar inspection by Sir F. Bramwell's assistant, Mr. G. Harris, the Gas Company now ask the Board of Trade to insert clauses in Mr. Massingham's licence which would virtually place the electric light enterprise at their mercy. As, however, the provisions usually contained in licences and orders afford ample protection to gas and water mains, it is improbable that the Board of Trade will substitute for them the one-sided clauses proposed.

Messrs. T. Commerford Martin and Joseph Wetzler, the able and well-known associate editors of the *Electrical World* of New York, have severed their connection with that journal, and now occupy similar positions on the editorial staff of the *Electrical Engineer* of New York, which will in future appear every week. The new editor of the *Electrical World* is Dr. Louis Bell, whose recent contributions to electric traction literature have been as much appreciated in this country as in the United States. Under the ægis of Dr. Bell the *Electrical World*, it may be anticipated, will continue to hold the leading position amongst American electrical journals.

Royal Institution.—The general monthly meeting of the Institution will be held on Monday, April 7th, at 5 p.m.

Strasburg.—The Town Council have granted a concession to Messrs. Schulze and Isenbeck for the erection of a central station for the supply of light and power.

The North Metropolitan Tramway Company.—This Company have obtained their Bill for the application of electric traction to the whole of their system.

St. George-the-Martyr Vestry.—At the last meeting of this vestry it was decided to assent to the Provisional Order of the London Electric Supply Corporation.

St. James' Vestry.—At the last meeting of this Vestry it was resolved to give consent to the Provisional Order of the St. James' and Pall Mall Electric Light Company.

Northampton.—The licence of the Northampton Electric Light Company having been received from the Board of Trade the Company will shortly commence to lay its mains.

Preston.—At the last meeting of the Town Council it was unanimously resolved to assent to the application by the National Electric Light Supply Company for a Provisional Order.

Treatment of Goitre by Electricity.—Dr. Marano reports the complete cure of a goitre of considerable size and of three years' duration by electricity, in the form of strong external currents and electrolysis alternately.

The Copper Market.—According to Messrs. H. Merton's statistics, the visible stocks of copper on March 31st were 91,938 tons, contrasted with 95,152 tons on February 28th last, and 124,876 tons on March 31st, 1889.

Electric Welding.—Several members of the South Staffordshire Institute of Iron and Steelworks Managers paid a visit to the Birmingham Compressed Air Company's works on Thursday last week, to witness experiments in electric welding.

Birmingham.—At the last meeting of the Town Council the General Purposes Committee were authorised to provide for the lighting of the Victoria Courts by electricity by the Birmingham Electric Supply Company, at an estimated cost not exceeding £2,000.

Post Office Telegraph Revenue.—The revenue returns to the end of the financial year ended March 31, 1890, show that the receipts from the telegraph service amounted to £2,320,000.

Digitized by Google

an increase of £240,000 over the receipts of the preceding financial year.

Aberdeen.—At the last meeting of the Gas Committee of the Town Council a communication was read from the Board of Trade to the effect that they were about to bring in a Bill vesting in the Gas Corporations the management of the electric lighting of the burghs.

The Sheffield Telephone Exchange.—Her Majesty's Treasury have given their sanction to the construction by the Postmaster-General of a special line direct from Sheffield to Manchester, for the purpose of connecting the Sheffield Telephone Exchange with that town and district.

Breslau.—The town authorities have voted 1,000,000 marks (£50,000) and have given the contract for installing 10,000 16-candle-power lights to Messrs. Siemens and Halske. The work is to be completed by March 1, 1891, and the town will work the installation when it is completed.

Berlin.—Negotiations are pending between the Directors of the Grosse Berliner Pferdebahn-Gesellschaft and the Berliner Elektricitäts-Werken, with a view to the introduction of electric traction on their lines. It is said that the Friedrichstrasse-Kreuzberg line will be the first to be tried.

Institution of Electrical Engineers.—At the next meeting of the Institution, on Thursday, April 10th, the following Papers will be read:—"On Signalling across Rivers in India," by W. T. Melhuish, member. "The Diathermancy of Air in relation to the Efficiency of Incandescent Lamps," by Frederick Higgins, member.

Verona.—According to *l'Elettricita*, the people of Verona are greatly in favour of the electrical scheme of Signor Enrico Carlo, who proposes to obtain the power necessary for electric lighting of the town from the River Adda, near Lecco, a distance of about 100 miles. The power available is estimated at between 7,000 and 11,000 horse-power.

Electric Traction at Liverpool. — General Hutchinson, Inspector to the Board of Trade, last week inspected and approved the car which the Electric Traction Company are about to run for experimental purposes on the Liverpool United Tramways. To meet the heavy gradients on this line, a heavier motor will be used, and both axles will be operated.

Bolton.—In reply to 1,178 circulars issued by the Corporation in connection with the question of electric lighting, 449 replies have been received: 45 only desire the electric light, but they include the large firm of Messrs. Musgrave and Sons; 24 wish for it if the price is the same as gas; 56 are uncertain by reason of the cost; doubtful, 30; and absolute negative, 314.

The Telephone at Bakewell (Derby).—Something unique may be seen in Bakewell (Derby), where some months ago the Sheffield Telephone Exchange Company extended their system by opening Exchanges in Baston and Bakewell. On Thursday last the National Telephone Company made a formal opening of a rival Exchange; and, strange to say, the switchboards of both companies may be seen installed in the same room.

Académie des Sciences.—In connection with the recent election of Lord Rayleigh as correspondent to the Physical Section of the Académie des Sciences, *La Lumière Electrique* points out that Lord Brougham, who was elected correspondent to the Section of Moral and Political Science in 1833, is the only other member of the House of Lords who has been connected in this way with the Institut de France.

Lambeth Vestry.—At a meeting of this Vestry on Thursday evening last week, it was agreed that consent should be given to the application of the House-to-House Electric Light Supply Company for a Provisional Order to extend over the whole parish, with the exception of two small areas, which have already been allotted to the London Electric Supply Corporation and the Electric Installation and Maintenance Company.

Leeds Association of Foremen Engineers and Draughtsmen.—The ordinary monthly meeting of this association was held on Thursday evening last, in the Physics Lecture Theatre of the Yorkshire College, Leeds, when Dr. W. Stroud, professor of physics at the College, gave a most interesting lecture on "Springs." The lecture was well illustrated by a large number of experiments, electrical and mechanical, and by lime-light views.

Magnet Steel.—The following testimonial, received from Prof. Perry by Messrs. Jowitt and Sons, of Sheffield, is of interest in view of the statements recently made by Mr. Preece with regard to the deterioration of magnet steel. Prof. Perry writes:—"I obtain an average *permanent* induction of 12,600 in your magnet steel. So far as I know, this is a much better result than has been obtained from any other steel. I use the steel in a glass-hard condition."

L'Elettricita.—The editor of *L'Elettricita*, which is published at Milan, would be glad to receive answers to the two following questions, from all competent electricians; these answers will be published in an early issue of our contemporary. 1. What has been the most important electrical invention, discovery, or investigation of the past year? 2. What application of electricity, already known, will make the greatest progress during the present year?

Altona.—From the *Elektrotechnische Echo* we learn that the municipal authorities of this town have given the contract for building a central station to Messrs. Schuckert and Co. The town retains the right to purchase the whole plant either on completion or at the expiration of certain stated periods. The station is designed for 10,000 glow lamps; but the plant for 5,000 only will be put down at first. The work is to be completed by October 1, 1891.

The London Chamber of Commerce.—At the eighth annual general meeting of this Chamber, held on Monday, Sir John Lubbock, in moving the adoption of the report, expressed congratulation on the continued progress of the institution. The number of new members elected during the past year had been 470, which was more than 100 above the average, the total number of members now exceeding 3,000. There were 24 trade sections, five having been added during the year, and others were in course of formation.

Berlin.—Mr. J. S. Biggs, vice-president of the Edison Lighting Company of New York, and Mr. C. L. Edgar, manager of the Edison Lighting Company of Boston, have been sent over to study the Berlin central stations. Both gentlemen have expressed their satisfaction with what they have seen. The *Elektrotechnische Zeitschrift* is of opinion that "the fact that the inventor of the incandescent lamp first comes himself, and then sends his two foremost engineers to study the Berlin central stations, ought to fill the German electrical world with pride."

The Telegraph in Burmah.—During the past year 3,117 miles of wire were added to the telegraph system of Upper and Lower Burmah. Permanent lines have been constructed from Sagaing to Myinma 32 miles in length, Meiktella to Meiktella Road 13 miles, Kindat to Tamu 48¼ miles, Bhamo to Mogaung 88⅓ miles. The number of messages decreased by 15·4 per cent., and their value by 44·4, as compared with the average of previous years. The reduction is accounted for by decrease in State traffic. In Upper Burmah the number of messages wired is given as 370,964, as compared with 564,066 in the previous year.

The Accumulator Cars on the Madeleine-Levallois Line.—The accumulator cars now being tried on the Madeleine-Levallois line of the Compagnie des Tramways Nord of Paris are four in number. The current is obtained from 108 cells of the Société Française d'Accumulateurs Électriques. The cells are placed on shelves arranged at the angles of the cars, and weigh 1,620 kilogrammes (1½ tons). The motor is of the Siemens type, and runs normally at 1,000 revolutions, the speed being reduced at the car axle in the ratio of 26 to 1 by endless cord gearing. Variations of speed are effected by altering the grouping of the cells. The cars, which carry 50 passengers, weigh 3,500 kilogrammes (3½ tons). The normal rate of travel is 11 kilometres per hour, at which speed the motor requires 200 volts and 16 amperes. The Société Française estimate the cost of accumulator traction at 30 centimes per car kilometre.

Digitized by Google

The Stepanoff Electric Bleaching Process.—In the method of electric bleaching devised by M. Stepanoff, common sea salt is employed instead of chloride of magnesium, as in the Hermite process. A solution of sea salt is pumped into an "electrolyser," having lead and platinum electrodes, and is there submitted to electrolytic action; after which the electrolysed solution is pumped into the bleaching tanks. With his present apparatus M. Stepanoff uses 40 amperes and 45 volts, and is able to furnish 300 litres (66 gallons) of chloruretted solution per hour. Although matters may be so arranged that a 1·6 per cent. solution can be obtained, M. Stepanoff does not, as a rule, employ a solution containing more than ·7 per cent. of chlorine. The substitution of lead for zinc electrodes in the "electrolysers" is claimed as an improvement.

A Recipe for Making Battery Boxes Watertight.—It is often advantageous to employ wooden vessels for battery and electro-plating purposes in place of the jars in ordinary use. It is, however, necessary that they should be perfectly watertight and unacted on by the electrolyte. M. Fontaine Atgier gives the following recipe for this purpose:—Coat the interior of the vessels with a hot liquid mixture of paraffin and gutta-percha, obtaining the requisite degree of polish by passing a hot iron over it after application. If it is desired to avoid applying the coating in a hot state, make a mixture composed of sulphate of carbon or of benzine, and gutta-percha and bitumen; the compound being applied with a brush. Care must in this case be taken to work at some distance away from any arc lamp or other powerful source of light.

The Edinburgh Exhibition.—By the invitation of Sir George Hayter Chubb the London Committee of the Edinburgh Exhibition and a number of gentlemen interested in its success were entertained to dinner in the Hôtel Métropole, last week. Amongst those present were the Secretary for Scotland, Lord Colville of Culross, the Lord Mayor of London, Sir Thomas Clark, chairman of Executive Council; Sir John Fowler, Sir Douglas Galton, Sir John Pender, K.C.M.G.; Sir Frederick Abel, C.B.; Sir V. Kennett Barrington, Sir James N. Douglas, C.E.; Prof. George Forbes, F.R.S.; and Mr. W. H. Preece.—Messrs. F. B. Seath and Co., of Glasgow, are making good progress with the electric launches to be run on the canal during the Exhibition. Each boat will carry 30 or 40 passengers, landing them most conveniently at the entrance to the building. It is also intended to run pleasure trips during the season.

Manila Paper Insulation for Telephone Cables.—The electricians of the American Bell Telephone Company have lately undertaken some experiments with a new type of telephone cable insulated with Manila paper. Other things being equal, the substitution of Manila paper for cotton diminishes the specific inductive capacity of a cable by 30 per cent.; and since the cost of insulating a cable in this way is very little more than the cost of insulating it in the ordinary manner, it may be anticipated that Manila-paper-insulated telephone cables will come into general use in the United States for underground work, should the experiments at present going on prove them to be satisfactory in other respects. According to Mr. Barrett, Manila paper is less hygroscopic than cotton. The paper can be wrapped very tightly round the wires, and the insulated covering presents a shiny, smooth, flexible surface.

The Langhans Incandescent Lamp.—The main characteristics of the Langhans incandescent lamp are the low vacuum it requires and the employment of a metallic filament coated with silicium. As a vacuum corresponding to about 1 millimetre is all that is necessary, it can be produced by a mechanical vacuum pump specially constructed for the purpose by Mr. Langhans. The several processes employed in coating the filaments with silicium are simple, inexpensive, and permit of a high degree of accuracy in predetermining the voltage. The life of the Langhans filament at 2·75 watts per candle-power is said to be equal to that of the best carbon makes. Ordinary carbon filaments can be coated with silicium by the Langhans process, and it is claimed that they then require less current in order to give the same amount of light, and can be made to work satisfactorily in the same low vacuum as the Langhans filament proper.

The Marx Accumulator.—The principle of an accumulator recently brought out by Herr Marx, of Berlin, is briefly as follows:—If an electric current is passed through a dilute solution of hydrochloric acid and perchloride of iron, in which are immersed carbon electrodes, the following reaction takes place:—$2\,FeCl_2 + 2HCP = Fe_2Cl_6 + H_2$. If, then, a carbon and an iron electrode are plunged into the electrolyte the following reverse reaction, giving rise to a powerful current, takes place, $Fe_2Cl_6 + H_2O = 2\,FeCl_2 + 2\,HCl + O$. The perchloride may be prepared by taking 450 parts of protochloride of iron, 900 of water, and 500 of hydrochloric acid (25 per cent.). The perchloride can then be concentrated, or even crystallised by evaporation, and in that state may be carried about. The carbon electrode in the second case must be very porous, or pierced with numerous holes. The iron electrodes are not consumed; on the contrary, an open circuit iron is deposited on them, so that they must be removed when the battery is not at work.

Alloys for Standard Resistances.—At a recent meeting of the Berlin Physical Society, Dr. Feussner, in describing the methods employed at the Government Physico-technical Institute for the measurement of electrical resistances, remarked that German silver wires had shown themselves unsuited for standard resistances, since their resistance increases regularly with lapse of time. On this account an alloy of copper and nickel was examined which is known commercially as "patent nickel." Wires made of this alloy possess a very low temperature-coefficient, and were found to be almost absolutely constant after being heated to 100° C. Several other alloys were also tried, as, for instance, various combinations of copper and manganese. Dr. Feussner stated that up to 30 per cent. of manganese—above which amount it was not possible to draw a wire in this alloy—they had yielded a negative temperature-coefficient. When the alloy contained only a small percentage of manganese, the coefficient was very small, so that such wires would be suitable for the construction of standard coils.

The Distant Operation of Water Gates by Electricity.—The Elektron Manufacturing Company, of Brooklyn, have recently built two Perret motors for the purpose of operating some hydraulic gates at a distance of several miles. One motor is to be used at Marion, O., at a distance of three miles, and the other to be used at Decatur, Ala., at a distance of a mile or more from the operator. The dynamo used in each case is a small constant-current machine. By changing the direction of the current at the dynamos, the motors, which are series-wound, are run in either direction at will. The reversal of motion is effected by an ingenious automatic device, invented by Mr. Frank A. Perret, the electrician of the Elektron Manufacturing Company, which is attached to the motor and keeps the polarity of the fields unchanged regardless of change in direction of the current on the line, while the current in the armature is reversed with each change in the main current. The water gates are thus controlled and placed in any desired position at the will of the operator miles away, by simply throwing a switch lever.

The Electric Welding of Wire Cables.—Electric-welding machines are being erected by the Trenton Iron Company (N.J.) for the purpose of welding cables by the Thomson electric welding process. The cables to be welded are 1¼in. in diameter, and are composed of four successive layers of wires, with a single fine wire core. Experiments made with a view to determine the tensile strength of the welds produced in this manner show that the maximum tensile strength of a cable was 67,000lb. per square inch before annealing, and about 50,500lb. after heating to a temperature slightly below a welding heat, and then allowing the metal to cool slowly, and that the tensile strength of the welded cable averages over 50,000lb., some specimens resisting a stress of as much as 53,000 or 54,000lb. per square inch. The ratio of elastic limit to ultimate tensile strength is about the same in unwelded as in welded specimens. Severe bending and twisting tests give equally good results, it being possible to bend the cable at the weld backwards and forwards many times through an angle of 180deg.

Digitized by Google

Telegraphing the Progress of the Boat Race.—A successful attempt was made this year for the first time by the Exchange Telegraph Company to signal to their subscribers the progress of the Oxford and Cambridge boat race. Those connected with this Company's system were thus made acquainted with the time of arrival of the competing crews at various points of the course, and the relative positions which they occupied at intervals of a few minutes, the result being made known at 800 places in London alone a few seconds after the termination of the race. Not only were the London clubs and others thus supplied with an account of the race, unattainable on the course itself, but newspapers in the country were enabled to go to press with a complete and accurate description much earlier than has hitherto been possible. An example of the promptitude of delivery of this news was furnished by the *Manchester Evening News*, which was being sold in the streets of Manchester at 5.20 p.m., with the description of the race from start to finish, this being only 14 minutes after the conclusion of the race at Mortlake.

The Municipal Tariff at the Halles Centrales.—The *Bulletin International de l'Electricité* has discovered some curious anomalies in the tariff drawn up by the Director of the Paris Municipal Central Lighting Station at the Halles Centrales. The energy consumed is charged for at the rate of 15 centimes per 100 watt-hours. Any consumer, however, whose lamps have all burnt on an average 150 hours per month, has 10 per cent. taken off his monthly bill; if the average attains 180 hours a 20 per cent. reduction is made; and 30 per cent. is deducted if the lamps have all burnt 200 hours during the month. The result of these liberal discounts, in the case, for instance, of an installation of ten 16-candle-power lights, is somewhat startling:—If the ten lamps are used 149 hours per month, the bill will amount in round numbers to 143fr.; if used 150 hours, the charge will only be 129fr. 60c.; while for ten lamps burning 181 and 201 hours per month, the charges will be respectively 139fr. and 135fr. An increase of over 30 per cent. in the consumption may thus result in a 5½ per cent. diminution of the consumer's bill.

The Tatlow Battery.—This battery is composed of a zinc and peroxide of lead couple in dilute sulphuric acid. The peroxide of lead is obtained as follows: A lead foundation plate is filled in with a paste of lead oxides, made of red lead and sulphuric acid, or litharge and lead acetate solution—a plate, in fact, similar to an ordinary storage battery plate. When the paste has set hard the plate is placed in a solution of chloride of lime, whereby the salts and oxides of lead are gradually oxidised to lead peroxide, the rapidity of the reaction depending on the temperature and degree of concentration of the solution. It is absolutely necessary that there should be enough free lime present to keep the liquid alkaline. When completely oxidised the plate is taken out of the solution, well washed, and is ready for use in the cell, giving with zinc and dilute sulphuric acid an E.M.F. of 2 to 2·3 volts. After the plate has ceased to be active it is to be washed and returned to the hypochlorite solution. The same plate thus serves again and again, acting as a carrier of oxygen between the hypochlorite and the zinc. The reaction in the hypochlorite solution possibly involves the formation of a lead or lead-calcium hypochlorite during the process.

The Agitation amongst the Telegraph Clerks.—The Postmaster-General received on Monday a small deputation representing the telegraphists previously employed by the Submarine Telegraph Company, and who are now in Government employ. These men, who share with the other telegraphists various grievances, have also their own special grievances. They complained that they were unfairly classified, that their superior work was not taken in consideration, and that they had been deprived of the benefits of a generous scheme of life insurance which they enjoyed under the old Submarine Company. They also asserted that, although the Continental service necessitated a knowledge of foreign languages on the part of the telegraphists, no allowance was made for such special acquirements. The Postmaster-General, having listened to statements in support of the memorial, said that the whole subject was under the consideration of the Department, and the deputation withdrew.—The following is the resolution which Lord Compton will move in the House of Commons on Tuesday, the 15th, with reference to the telegraphists, "That, in the opinion of this House, the present position of telegraphists in London and elsewhere is unsatisfactory, and their just grievances require redress."

Frankfort International Electro-Technical Exhibition, 1891.—We have received from the Executive Committee of this Exhibition particulars with regard to charges for space, forms of application, &c. The Exhibition will be opened on May 15, 1891, and will close on October 15th. The exhibits will be classified under twelve sections:—I. Motors for electro-technical purposes. II. Generation of electricity. III. Conductors and auxiliary apparatus. IV. Accumulators and switches. V. Transmission of electric power. VI. Electric lighting. VII. Telegraphic and telephonic apparatus. VIII. Electric signalling. IX. Electro metallurgy and electrolysis. X. Measuring instruments. XI. Medical electricity. XII. Electro-technical literature. Applications for space must be sent to the Executive Committee before July 1st, 1890. The delivery of exhibits which will require some time to erect may commence on March 15, 1891, and must be completed on April 15th. Other exhibits may be sent in up to May 1st. The charges for space are as follows:—A. Main building, 15 marks the square metre (about 1s. 5d. the square foot). B. Semi-covered space, 10 marks the square metre. C. Open air, 2 marks the square metre. The cost of insurance is to be paid by the exhibitors. The charge for power will be 1½d. per horse-power hour, 3 horse-power being the minimum.

The Measurement of Electro-Magnetic Radiation.—At the last meeting of the Physical Society of Berlin, Dr. Rubens spoke on the employment of the bolometer for observing the electrical radiations of Hertz as carried out by himself and Dr. Ritter. Up to the present it had not been found possible to measure the intensity of the radiation, owing to the extraordinarily minute amplitude of the oscillations; but the speaker had been able to carry out the determination by means of a special form of bolometer. It consists essentially of an accurately balanced primary Wheatstone bridge, two of whose arms are again converted into secondary Wheatstone bridges. If a current passes through one of them its resistance is altered by the rise of temperature, and the galvanometer gives a proportionate throw. A similar effect is produced by a wave of electrical radiation, and hence its amplitude can be measured by this bolometer when once it has been calibrated. When experimenting with the polarising wire-grating it was found that there is a constant relationship between the intensity of the rays which pass the grating and the angle of inclination of the wires to the plane of oscillation of the rays. It was further observed that the energy which does not pass the grating is reflected, and to the extent of 98 per cent., when the wires are at right-angles to the plane of oscillation.

Specific Inductive Capacity of Rarefied Air.—In a recent Paper (see *The Electrician*, March 14, 1890), Dr. James Moser has shown that, while air rarefied to the extent common in Geissler tubes, is a conductor, a high vacuum is really an insulator. It was of interest to determine the specific inductive capacity of air in these two states, and with this view a Leyden jar was constructed with air as the dielectric. A Geissler pump was placed in communication with the condenser, and also with Dr. Moser's double vacuum tube already described. The former was used to rarefy the air, and the latter, when excited by an induction coil, to indicate by its appearance the state of rarefaction. Both were disconnected from the condenser when the capacity measurements were taken. A Mascart-Carpentier electrometer was used, whose capacity was comparable with that of the air condenser. The quadrants were charged with a Latimer Clark's cell, and the needle by communication with the air condenser, which had been previously charged by means of a Zamboni pile. The deflections produced should vary with the specific inductive capacity of the rarefied air, since the potential of the Leyden jar must fall on being connected with the needle by an amount depending on the ratio of the two capacities. The results obtained by Dr. Moser were, however, negative, no certain variation in the deflection being established.

Digitized by Google

MAGNETISM IN IRON AND OTHER METALS.*—XII.

BY PROF. J. A. EWING, F.R.S.

(*Continued from page 518.*)

§ 57. **Magnetic Force in Rings.**—Though the magnetising solenoid is uniformly wound over the whole ring, so that its effect at any one cross-section is the same as at any other, the magnetic force is not quite uniform throughout. It is strongest at the inner side—the shortest length—of the ring, and decreases towards the outer side in proportion as the radius of the ring increases. This is because the number of turns per centimetre is greatest at the inner side and least at the other. Let N be the whole number of turns of the magnetising solenoid, the number per centimetre at any radius r is $\frac{N}{2\pi r}$ and the magnetic force is $\frac{4\pi CN}{2\pi r}$, or $\frac{2CN}{r}$. Thus the magnetic force varies from $\frac{2CN}{r_1}$ at the inside to $\frac{2CN}{r_2}$ at the outside (Fig. 24). So far as it goes, this is a drawback to the use of ring-shaped specimens.

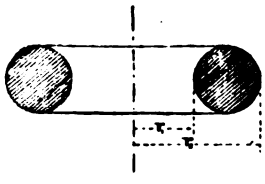


FIG. 24.

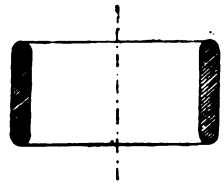


FIG. 25.

To prevent this objection from having much weight the thickness of the ring should be small compared with its radius. The form shown in Fig. 25 allows a small ring to be used without excessive variation of magnetic force over the section within, and without unduly reducing the sectional area.

In dealing with weak magnetic forces it is desirable to place the ring in such a position that the earth's magnetic field does not affect the uniformity of its magnetisation, namely, in the plane perpendicular to the direction of the lines of terrestrial force. For the sake of homogeneity in the metal itself, a ring turned out of a solid block is to be preferred to one that is forged from a bar.

§ 58. **Bar and Yoke.**—The condition of endlessness, which is realised perfectly in a ring of uniform section, uniformly wound (or, rather, is realised as perfectly as the imperfect homogeneity of the metal will allow), can be approximated to, even

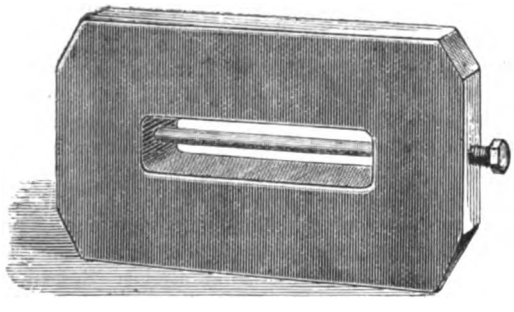


FIG. 26.—Yoke for the Ballistic Tests of Bars.

when the sample has the form of a short bar, by a very interesting and useful method, invented by Hopkinson.† Let the ends of the bar be sunk in holes in a massive yoke (Fig. 26) which has an area of cross-section many times greater than that of the bar, and is made of the most permeable material available, namely, soft annealed wrought iron. The yoke is so much better a conductor of lines of magnetic induction that the lines which proceed from either end of the bar nearly all pass back through it to the other end, instead of escaping into surrounding space. This closing of the magnetic circuit through the yoke prevents the bar from exercising almost any self-demagnetising force upon itself; and if the bar is wound with a magnetising solenoid throughout its whole clear length within the yoke,* the magnetic force actually operative on it is only a very little less than the whole force due to the solenoid.

The amount of the difference will be more easily discussed when we come, later, to speak of the magnetic circuit as a whole, and the relation of the induction in it to the whole number of ampere-turns in the magnetising coil. Meanwhile, it may suffice to say that the magnetism of the bar and yoke reacts to a small extent on the magnetic force, reducing it by amounts which are proportional, or nearly so, to the magnetisation. The effect is like that which has already been described as occurring in a long rod or long ellipsoid, not so extremely long as to be virtually endless, and the curve of magnetisation is consequently sheared over (§ 48): the apparent susceptibility and the residual magnetism are reduced. This makes the method of the yoke unsuitable for accurate determination of the susceptibility and retentiveness of a very susceptible metal, like soft wrought iron; but there is no material error in the case of hard iron or steel.

The ends of the bar should be sunk for a considerable distance into the yoke, and should fit in the holes without shake, for if there is any appreciable clearance its effect in causing self-demagnetising force may be considerable.

§ 59. **Hopkinson's Application of the Bar and Yoke.**—In applying the ballistic method to a bar in a yoke we may, of course,

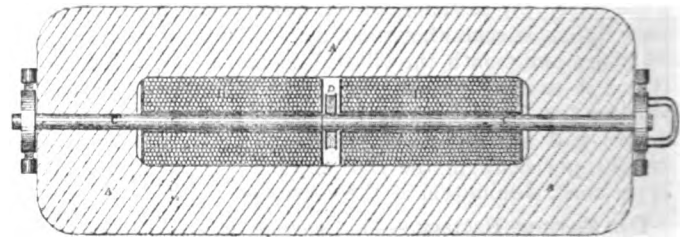


FIG. 27.

proceed by steps or by reversals, as with a ring. In Hopkinson's original use of the yoke, however, a different procedure was followed. The bar was made in two parts, C and C′ (Fig. 27), which abutted against one another near the middle, where the secondary coil D was slipped on, in a space between two halves of the magnetising solenoid B B. A clutch fixed on the projecting end of the rod C enabled it to be suddenly drawn away from C′ sufficiently to allow D (which was pulled sideways by a spring) to leap out of the field. This gave a ballistic throw which measured the actual magnetic state of the bar at the moment when C was drawn out. The plane of section between C and C′ is a rather objectionable feature in this arrangement: for, as will be shown later, its influence on the general permeability of the bar is by no means immaterial, even when the abutting surfaces are accurately faced.

§ 60. **Double Bars and Yokes.**—Figure 28 illustrates an arrangement which should serve well when two equal bars of

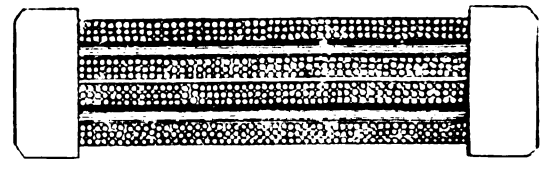


FIG. 28.

the material to be tested are available. The bars should be of considerable length—twenty or more times the diameter, and the yoke should be short and thick. Equal magnetising solenoids are wound over each, and are connected to give opposite directions

* All rights are reserved.

† "Magnetisation of Iron," *Phil. Trans.*, 1885, p. 455.

* In the figure the bar is shown in its place, but the magnetising solenoid and the induction coil are omitted.

Digitized by Google

of magnetisation. The secondary coil is preferably distributed over the middle region of both bars. If it is wished to measure the actual magnetic state at any time, one of the yokes may be arranged so that on pulling it away it brings the secondary coils with it.

(To be continued.)

ELECTRIC ARC LIGHT CARBONS.

BY O. G. PRITCHARD.

(Continued from page 494.)

Having described in my previous Paper the graphitic material or compound used in carbon candle-making, the manipulation required in the preparation of the stuff, also the way in which the granular condition is acquired, and which experience shows is essential to the production of a good carbon, I now proceed to explain the method of preparation of the saccharine matter employed in combining the material to form the paste, or pugged stuff possessing the special properties requisite. All materials hitherto experimented upon and used to combine the powdered graphite, such as tar, oils, gums, hydro-carbons, rosin oil, &c., swell the carbons, after being subjected to a drying heat, inducing porosity; and no available after-process is satisfactory. Saturation with carbonised sugar fills the pores, but leads to much waste of time and enhanced expense, both of material and labour. Wellnigh two of the first years which I devoted to this subject were spent in efforts to overcome this difficulty, efforts not made in vain, since not only is the perfect drying of the carbon without swelling now a "*fait accompli*;" but also the valuable property of contracting under great heat has been realised, so much so, indeed, that allowance has now to be made in the gauge of the die, which, to allow for this contraction, requires to be increased $\frac{2}{16}$th of a millimetre upon a 10-millimetre carbon. Prolongation and intensity of firing increase the contraction. The high conductivity possessed by graphite is, no doubt, due to its peculiar dense condition; but to impart this quality of density we shall have to wait until Nature invites us to work in her own laboratory.

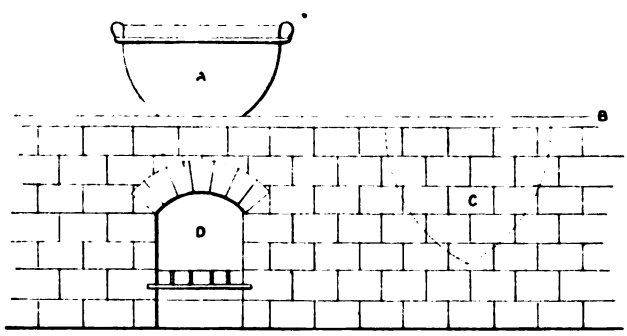


FIG. 1.

The material I use to incorporate with the prepared graphite powder is the best crystallised lump sugar. Crystallised Demerara might do as well, but the difference in cost is so slight that I prefer to adhere to the former; and, therefore, would cite "Tate's cubes" as the standard. I would urge that no attempts be made to cheapen this part of the process. Molasses and treacle are impure, containing, besides sugar, acetate and sulphate of potassa, chloride of potassium, phosphate of lime and copper, mucilaginous and nitrogenous matters, silica, water, and glucose.

Take, say, 20lb. of Tate's cubes, put them into a boiler large enough to hold four times the quantity, at least; place the boiler on a moderate fire, preferably made of small broken coke, and allow the sugar to melt gradually, without burning, until it partially carbonises. Careful stirring and watching must be exercised, and it must never be at any moment left, or the sugar is certain to boil over, catch fire, and be wasted. To avoid these *contretemps*, a low range of firebricks may be built (see Fig. 1), on the top of which bars, B, of iron are fixed, immediately over the fire, and extending over a sunk pan, C. The boiler A is free to slide upon the bars, so that in the event of a sudden rise it can be pushed over the sunk pan, and any overflow of the contents be recovered without loss.

I have signally failed in the use of beet sugar. When converted into caramel, it decidedly loses the adhesive, sticky property belonging to the cane sugar. Sugar heated to 400° F. loses two equivalents of water, becomes brown, cannot be re-crystallised, and is then known as caramel. At 410° F., the third equivalent of water is set free, and complete carbonisation commences. In this state the spec. grav. is 1·594. Sugar at this stage ceases to rise in the boiler. By observation alone can the point at which the caramel is in the exact state required be determined. As a guide, however, it may be stated that the process is well-nigh completed when the sugar ceases to rise in the boiler; but make sure that this is not owing to the lowering of the fire. Small volcanic eruptions covering the surface, bursting and emitting vapours which are caused by the third equivalent of water becoming free, is another sign. If any smoke accompanies the vapour, the operation is certainly complete. The process had always better be carried a little too far than not far enough. In the first case, the caramel is only slightly less adhesive, leading to extra pugging; but in the second case the carbons will suffer, and this will not be ascertained until the carbons have been made and placed in the drying-room. To determine the right moment for closing the operation above described, needs practice, the appearances shown whilst boiling depending much upon the state of the fire, and being sometimes misleading and puzzling to any but the expert. When the boiler has been duly removed from the fire, add gradually *small* quantities of hot water. Adding cold water in bulk is an experiment not likely to be repeated more than once. Stir well while adding the water, and let this be only sufficient to keep the caramel liquid when cold. When required for use this stock must be diluted with cold water to about the consistency of golden syrup one part, water two parts, possessing a slight stickiness when rubbed between the fingers.

The carbon powder may now be taken out of the storage bin, in quantity sufficient for a pugging, with a pug-mill 6ft. 6in. over all, with rollers 18cwt. each. A 10 horse-power engine is sufficient to drive the mill and the press. About three tin buckets, holding about 20lb. each of the powder, may be taken as a charge, and this weight of material will suffice to form 1,000 10-millimetre carbons. Pug this stuff, adding sufficient of the liquid caramel to form a paste; when pugged, clear out the mill, and transfer the paste to a covered bin, or keep it in the buckets, marking the date when first pugged on the buckets. Continue making these batches, repugging every day until ready for the press. This pug-mill should be kept solely for the purpose of pugging, and not grinding, as the pan could not be so thoroughly cleaned as to avoid the risk of leaving some small fragments of material, which would find their way into the carbon rods, tend to divert the current when used, and give rise to complaints.

A portion of each day may be employed in pugging new stuff, previous puggings must also have the process repeated daily, each day's batches being kept separate. Three or four days, depending somewhat on the temperature, will bring the stuff to a proper condition for forming into carbons. The paste may be advanced, if required, by placing it in a warm room. By squeezing the paste in the hand the expert can tell the atmospheric pressure requisite to drive it through the press within some 10 atmospheres. This pressure must not be under 120 atmospheres for a 10-millimetre carbon. This same paste, however, that requires 120 atmospheres for 10 millimetres, would in the case of 14 millimetres pass through at 90 to 100 atmospheres. The first few carbons issuing from the press will be no guide, as the pressure will increase until the carbon in the cylinder becomes well compacted; this will occur whenever the cylinder has been emptied for the purpose of changing the die or altering the coring needle. If the cylinder has been charged, the pressure right, and the carbons issuing from the die, the carbons will require cutting to normal lengths. For this purpose I use a small instrument, which answers the

Digitized by Google

purpose, and cuts off the carbons to a standard length as they issue from the press. It is made of tin, about three-quarters of an inch wide, bent at right angles at D (Fig. 2). The carbon rod A, shown in section, lies in the grooved top B, the thumb slightly pressing the carbon, while the spring-back cutting part is pressed forward with the fingers; this closes over the groove B, separating the carbon at the normal length.

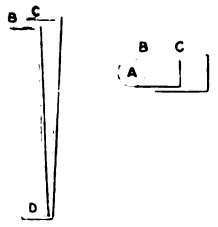


Fig. 2.

As the carbons are thus cut off they must be laid in grooved plates, prepared by a machine (Fig. 3) constructed for the purpose, consisting of a cast-iron frame, with grooved dies; the lower die B is fixed to the frame EE, whilst the upper die A slides vertically in the frame. This upper die is actuated by a lever handle C, working eccentric chuck-pieces, fastened to each end of the bar, actuated by the lever, and turned by the handle so as by its action to bring the dies in contact. The sheet tin, being laid upon the guide-plate G, is pushed forward through

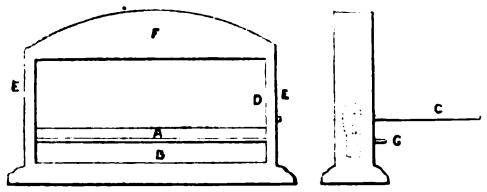


Fig. 3.

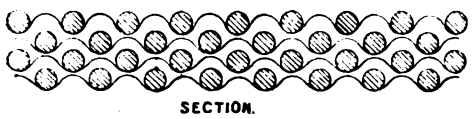


Fig. 4.

the open dies, and takes the form of the grooves upon lowering the arm; an iron rod at the back also guides the plate in its passage, keeping the grooved plate straight. These dies may be taken out of the frame to give place to others suitable for carbons of other gauge. These grooved plates (Fig. 4) upon which the carbons are carefully laid as soon as they issue from the press, are so constructed and figured that the carbon rods are perfectly protected from the superimposed plates pressing upon them, the plates resting upon each other, the carbons

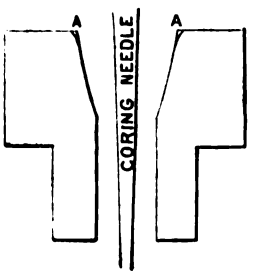


Fig. 5.

being protected withint he grooves; thus a dozen plates filled with carbons may be safely piled one upon another before leaving the pressman. These plates should be made two inches longer than the carbons, of the best charcoal tin, and rather stout. In these corrugated plates the carbons should remain until removed for firing in the kiln, tin being a good conductor of heat, accelerating the process of drying. When the pressman has filled a dozen of these plates they may be placed on a rack in the press-room. Here they may remain until the evening, when they may be transferred to the first drying-room.

I must here describe a fault which may arise by the time this stage is reached. The carbon rods leave the press, to all appearance perfect; half-an-hour afterwards every carbon is lined with fine fissures at right angles to the length of the carbon rod, increasing in size and depth as they dry. The fault arises from the die. I had occasion at the time I first noticed this defect to renew my stock of dies, and

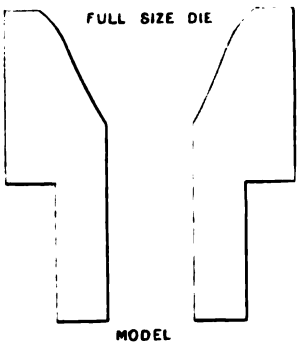


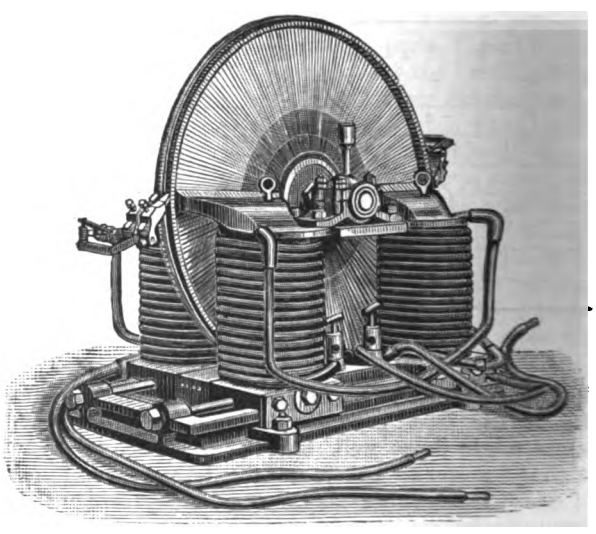
Fig. 6.

gave a model to an experienced workman, who furnished me with duplicates, apparently in every respect similar to model, only slightly reduced in gauge. No eye-measurement could detect any difference; but on slightly filing off the shoulder at A (Fig. 5) the difficulty disappeared, and the carbons were perfectly freed from this blemish. A model die for a 10-millimetre carbon is shown in Fig. 6.

(To be continued.)

THE POLECHKO DISC DYNAMO.*

The following details relating to this dynamo were given by its designer at the recent Congress of Russian naturalists. The inventor seems to have attempted to design a commercial dynamo on the principle of Barlow's wheel. The armature of M. Polechko's dynamo (*see* figure) consists of a single piece of metal, one metre in



Polechko Disc Dynamo.

diameter, insulated from the shaft, and cut radially into 350 segments, separated from one another by fibre to within 13 centimetres of the shaft. The periphery of the disc is furnished with a steel rim, insulated from the disc itself, and widened out on either side of the disc, so as to serve as a collector.

In a machine of this character, the E.M.F. which can be usefully induced along a segment may be calculated as follows:—Let a_1 be the radius of the disc, and a the radius of the centre portion. Then the length of the conductor l within the magnetic field is

$$l = a_1 - a.$$

* From *La Lumière Électrique.*

Digitized by Google

Let n = the number of revolutions per second. Then v, the mean linear velocity of each radial portion of the disc, is

$$v = 2\pi \frac{a_1 + a}{2} n.$$

Calling H the intensity of the magnetic field in C.-G.-S. units, the E.M.F. in volts induced in each radial segment is as follows :—

$$e = \frac{n\,H\,v\,l}{10^8} = \frac{n\,H}{10^8}\pi(a_1 + a)(a_1 - a) = \frac{n\,H}{10^8}\pi(a_1^2 - a^2).$$

The total E.M.F. induced in two opposite segments is—

$$E = \frac{2\,n\,H\,v\,l}{10^8} = \frac{2\,n\,H}{10^8}\pi\,(a_1^2 - a^2) = \frac{2\,n\,H}{10^8}S,$$

S being equal to $\pi(a_1^2 - a^2)$—that is to say, the active surface of the disc.

According to this formula, and with the dimensions of the first machine constructed by M. Polechko, we find that at a speed of 1,600 per minute the dynamo could develop 50 volts when H = 12,600. As a matter of fact, in the first machine, H was only equal to 6,500, and the machine gave 25 volts and 2,000 amperes at 1,500 revolutions per minute, its weight being 1,140 kilogrammes (about 22 cwt.). At the present moment M. Polechko is constructing a modified machine, having almost the same dimensions as the first, and it is possible that these dynamos, of solid construction, small weight, and extreme simplicity, may prove useful in electrolysis, electro-metallurgy, and even electric lighting.

THE PHYSICAL SOCIETY.

At the meeting of this Society, held on the 21st inst., Mr. H. Tomlinson, F.R.S., read a Paper on

"The Villari Critical Points of Nickel and Iron."

The author began by recalling the fact that Villari was the first to discover that longitudinal traction increased the magnetic permeability of iron for values of the magnetising force below a certain critical point, and diminished it for higher values. This critical value of the magnetising force, for which longitudinal traction had no effect, was therefore known as the Villari critical point. As far as he was aware no observer had succeeded in finding a similar critical point for nickel, and he understood that Prof. J. J. Thomson had theoretically arrived at the conclusion that no such point could exist. Having regard, however, to the temporary magnetisation only, the author stated that he had succeeded in finding a Villari critical point for nickel. The ballistic method of observation described in the *Philosophical Magazine*, Vol. XXV., 1888, p. 372, was employed in the experiment described in the present Paper. The nickel wire contained about 98 per cent. of pure nickel, and only 0·7 per cent. of iron, while the iron wire he believed to be nearly pure, judging from its low specific resistance. In the diagrams exhibited by the author the abscissæ represented the load applied to the wire in kilogrammes, while the ordinates represented the corresponding percentage alterations of permeability under the magnetising forces indicated for each curve.

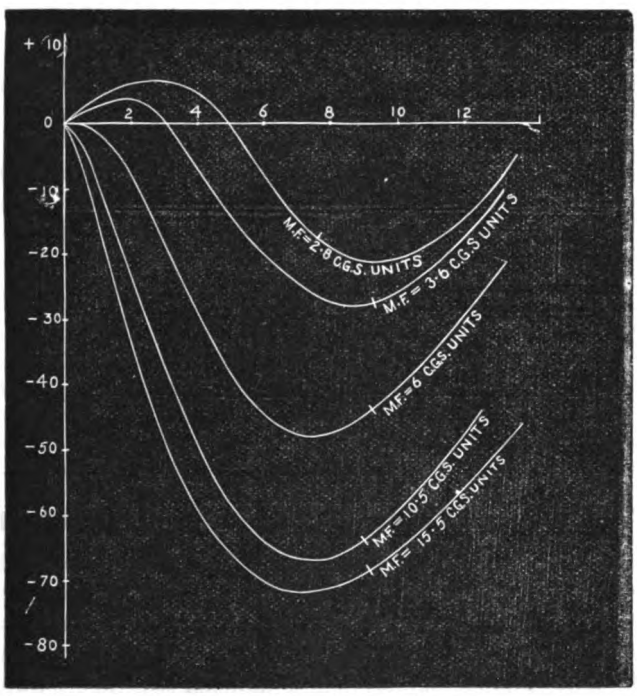


Fig. 1.—Iron Wire, 1mm. in diameter

The first experiment was made with iron wire. The highest load of 12 kilos was (Fig. 1) first applied to the wire, and a magnetising force of one of the values indicated was then alternately applied (always in the same direction) and removed, until the ballistic galvanometer deflection became equal in each case. This operation was then repeated with the load off. Successive loads, beginning at 2 kilos up to 12 kilos, were then applied, these operations being repeated at each step. Two series of experiments were made, the first beginning with the highest value of the magnetising force, and the second beginning with the lowest value, but there was no perceptible difference in the results obtained. As was to be expected, each change of load gave rise to an alteration in the residual magnetism, but the method of observation adopted gave only the temporary effect, this being what was required. Sir William Thomson had already observed that the Villari critical value of the magnetising force diminished as the load increased ; but in his experiments the whole magnetic effect was observed, and the decrease was much less than in the author's experiments, where the temporary effect only was observed. This suggested that a critical point might be found for nickel with respect to the temporary effect only, and curves obtained for nickel in the same way (Fig. 2) as those for iron show the critical point quite as markedly as in iron ; but in the case of nickel the curves show that the critical value increases with increasing load, and for a given load is higher in nickel than in iron. When the experiments on iron wire recorded by the curves shown in Fig. 1 were repeated with the same loads, but at a temperature of 200° C. instead of the ordinary temperature, the curves cut the load-lines twice, so that for a given magnetising force there are two loads which leave the temporary magnetisation unaffected. The same result was obtained at the ordinary temperature by employing greater loads. In this case the wire was lengthened by about 10 per cent. of its original length by loading it nearly to the breaking point, while in the former experiments there was no permanent extension. The maximum decrease of permeability was found to increase with the magnetising force up to a value of the latter of about 16 C.-G.-S. units, after which it slowly diminishes. Permanent extension lowers the Villari point in iron. *The nickel wire in the experiments* (Fig. 2) *was permanently elongated, but it is clear that the curves would not cut the load-line a second time.* Some further experiments with nickel showed that there was very little lagging of the mechanical strain behind the stress, the readings on loading and unloading being very nearly identical. The author in connection with this pointed out that Prof. Ewing had found that nickel exhibits very little magnetic hysteresis.

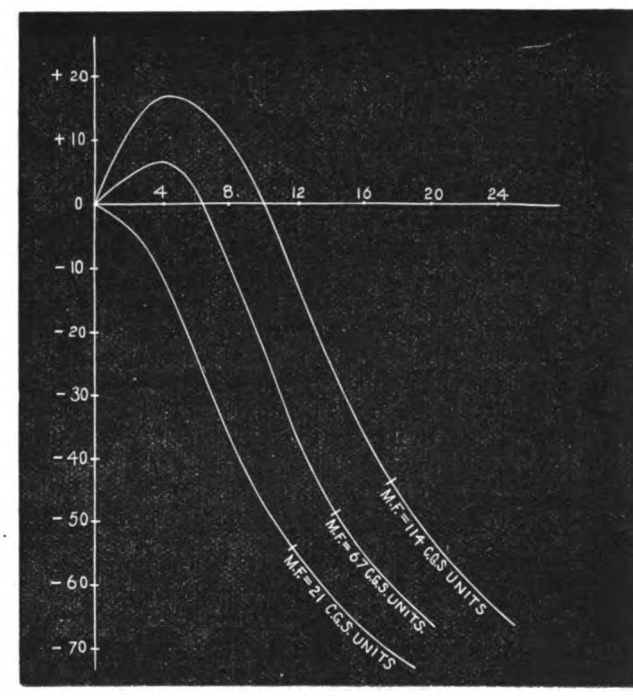


Fig. 2.—Nickel Wire, 8mm. in diameter.

Further experiments on both iron and nickel gave almost exactly the same curves for magnetising forces, varying from 0·03 to 0·3 C.-G.-S. units, and with wires which had been stretched nearly to breaking point there was practically no permanent magnetisation.

Digitized by Google

The Electrician.

Published every Friday. Price Fourpence; Post Free, Fourpence Halfpenny.
Editorial, Publishing and Printing Offices:

SALISBURY COURT, FLEET ST., LONDON, E.C.

Telephone No. 2714. Telegrams: "ELECTRICIAN NEWSPAPER, LONDON."

All Communications to be addressed to "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN."

All letters intended for insertion in "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. Subscribers should receive their copies by the first post on Friday morning.*

"THE ELECTRICIAN" *is on sale at the railway bookstalls throughout the United Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices as above.*

SPECIAL NOTICE.

Owing to the increase in the number of pages of "THE ELECTRICIAN," in order to partly cover the increased postage, we have been compelled to revise the rates for Foreign Subscriptions, which are now as follows:—

	3 months.	6 months.	12 months
For Foreign Parts and Colonies:—	s. d.	s. d.	s. d.
Within Postal Union	6 6	12 6	24 0
Aden, Borneo, Ceylon, China, India, Japan, Java Labuan Mozambique, New Caledonia, Persia, Philippine Islands, Siam, Transvaal, and Zanzibar	7 6	14 6	28 0

The rates for the United Kingdom remain as follows:— 5 0 ... 10 0 ... 19 6

TO ADVERTISERS.

"THE ELECTRICIAN" *offers exceptional advantages to Advertisers.* **It has the largest circulation of any English Electrical paper, and circulates all over the World.**

Particulars relating to Advertisements will be promptly forwarded on application to the office.

TRADE ADVERTISEMENTS *intended for the current issue must be handed in not later than First Post on Thursday morning.*

SMALL PREPAID ADVERTISEMENTS *(for Rates see page xv.) are accepted up to 4:30 p.m. on Thursday.*

TECHNICAL PRINTING.

"THE ELECTRICIAN" PRINTING AND PUBLISHING COMPANY (LIMITED) *beg to inform Electricians, Electric Light Engineers, &c., that they make a specialty of Technical Printing, and have a Staff thoroughly acquainted with Electro-Technology. They can, therefore, promise Accuracy and Despatch in the Printing of Electrical Catalogues and Electro-Technical Literature generally.*

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.

Royal 8vo, 5s., postage extra.

Early in each year is issued "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK. *The Directory was established in 1883, and the 1889 Edition consisted of more than 600 pages of printed matter. The names and addresses of all persons engaged in the Electrical Industries may be relied upon as accurate. Useful Tables and Electrical Formulæ, and information specially compiled for this work are given, together with popularly-written Biographical Notices of the leading Electricians, Electrical Engineers, &c., accompanied in many cases by Portraits.*

The issue for 1890, which is still further enlarged and improved (making 850 pages), is NOW READY. Orders should be forwarded at once to the Publishing Offices, Salisbury-court, Fleet-street, London, E.C.

CONTENTS OF THE CURRENT NUMBER.

NOTES 539
Magnetism in Iron and other Metals.—XII. By Prof. J. A. Ewing, F.R.S. Illustrated. Continued 544
Electric Arc Light Carbons. By O. G. Pritchard. Illustrated. Continued 545
The Polechko Disc Dynamo. Illustrated 546
Physical Society—
"The Villari Critical Points of Nickel and Iron. Illus. 547
THE INTERNATIONAL TELEGRAPH CONFERENCE 548
Reviews 549
Recalescence and Decalescence.. 550
The Institution of Electrical Engineers—
Alternating *v.* Continuous Currents in Relation to the Human Body. Illus... 551
American Notes 554
CORRESPONDENCE—
Alternate *v.* Continuous Currents in Relation to the Human Body. — George Forbes 555
Single *v.* Double Motors for Electric Cars. — O. T. Crosby 555
Dynamo and Motor Design. W. B. Sayers 555
The Fawcett Gas Engine. Illustrated 556
Paris Electric Meter Competition, 1890 556
Trade Notes and Notices 556
PATENT RECORD 557
COMPANIES' MEETINGS, &c.—
London Electric Supply Corporation (Limited) 558
Exeter Electric Light Company (Limited) 561
City Notes, &c. 561
Companies' Share List 562

"THE ELECTRICAL WORLD" OF NEW YORK.

"THE ELECTRICAL WORLD" OF NEW YORK *can be obtained from* "THE ELECTRICIAN" *Office, Salisbury-court, Fleet-street, London, E.C. The Rate of Subscription (payable in advance), is* **£1 1s.** *per annum. Single Copies* **price 6d. each; post free, 8d.**

"THE ELECTROTECHNISCHE-ZEITSCHRIFT" OF BERLIN.

In future the above journal (with which has been incorporated "The Centralblatt für Electrotechnik") will be issued weekly instead of fortnightly, the subscription being **£1. 4s. 6d.** *per annum. Single Copies* **6d.; post free, 7½d.**

"ANALES DE LA ELECTRICIDAD" OF BARCELONA.

Published fortnightly. Annual Subscription (Postal Union) Fifteen Pesetas. Single Copies **6d.; post free 7d.** *A Specimen Copy will be forwarded and subscriptions received by* "THE ELECTRICIAN" PRINTING AND PUBLISHING COMPANY, Ltd.

"THE ELECTRICIAN" PRINTING AND PUBLISHING COMPANY, Ltd., *are Agents in Great Britain for all the above well-known journals, and particulars as to Advertisements will be supplied on application to* "THE PUBLISHER," *1, 2, and 3, Salisbury Court, Fleet Street, E.C.*

THE INTERNATIONAL TELEGRAPH CONFERENCE.

After a separation of five years the Delegates of the world's telegraph administrations will meet again next month at Paris for the purpose of discussing those varied questions which have, doubtless, arisen in the interval connected with the tariffs and regulations of international telegraph business. There was always plenty for it to do when the Conference met every third year; but now that it meets only once in five or even six years, there is not only more work cut out for it, but much more risk of its adopting premature or ill-considered suggestions, rather than letting them remain suspended for another long term. The attempt on the part of the German Government at the last Conference, which was held at Berlin in 1885, to establish a uniform rate of 20 centimes per word for all European International telegrams, was a case of that kind, though, fortunately, defeated for the time being. It is hoped and believed, however, that the delegates from Great Britain will be equally mindful of British interests on this occasion.

Digitized by Google

On one point, at all events, it may be conjectured that all will have a common interest, namely, in putting the present system of coding on a rational and an equitable footing. It is expected that the regulations relating to code telegrams will come under review at the May Conference; and it is needless to add that there is here a great opportunity for relieving the telegraph systems of one of the worst abuses against which they have had to contend. We may have occasion later on to discuss the proposals which are expected to be placed before the Conference when they have taken a more official and concrete shape; but for the present all that need be said is that uniformity of practice, and intelligible rules for the guidance of the administrations and their customers, would go a great way to remove existing evils which have arisen partly at least through the indulgent laxity engendered by severe competition. If some common understanding can be brought about at the forthcoming Conference, it is pretty certain to be in the opposite direction, and therefore in the right one.

The Standing Committee, as it may be called, which is in permanent sitting at Berne, will do much to facilitate discussion on this and on other important questions which are to be decided by the International Delegates. The International Office, which is placed under the control of the Swiss Government, was one of the first good results of these periodic Conferences. It consists of a Director, a Secretary, and a staff of Clerks, whose duty it is to issue notices of all alterations of tariff, to prepare lists up to date of all established telegraph stations in the world, to keep them all informed of interruptions interfering with telegraphic communication, and generally to compile useful statistics relating to telegraph lines and the traffic passing over them. The office publishes a monthly *Journal* dealing entirely with telegraph affairs, prepares maps and papers for the use of the Conferences, and is in fact the repository of all subjects which are ripe or are ripening for formal discussion among the nations. It is maintained conjointly by all the Governments concerned; and needless to add that without it their quinquennial meetings would be indefinitely prolonged.

The work accomplished virtually through the instrumentality of this useful little bureau since its creation in 1865 strikes us nowadays as almost incredible. Before that date there were almost as many different charges for telegrams as there were places to telegraph to; the methods of counting varied in almost every country, the rates were based on no international coinage, and were extremely anomalous as regards distance and service charges. All this has been gradually altered. Beginning with a basis of twenty words, including addresses, the Conferences have been able from time to time to reduce the charges not only in amount, but in the direction of uniformity. The franc has been adopted as the basis of international rates, and all accounts rendered in the same currency. Extra-European telegraphy came also within its sphere of operation; and in one instance at least, namely, at the Berne Conference of 1871, a substantial increase in the overland charges to India was conceded to the just demands of the private companies. Not until 1875, however, was the distinction between European and extra-European traffic distinctly defined, when the Conference sitting at St. Petersburg promulgated two sets of regulations, the principal difference being that for extra-European telegrams the word-rate was made applicable. Four years later the European systems followed the same course, the London Conference of 1879 establishing the word-tariff for European as well as extra-European telegrams, with the judicious limitation in respect to the former of five words as the initial charge. After this heroic act the delegates rested from their labours for six years; and at the Berlin Conference of 1885 nothing of serious moment was enacted. It would give us much satisfaction to feel assured that the Convention of 1890 will be inspired with the same spirit of prudence and fair play; and although there remains much which the foreign delegates may legitimately do for the welfare of international telegraphy, their proceedings should be vigilantly watched by the official and non-official representatives of British interests on the spot.

REVIEWS.

Electric Light Installations and the Management of Accumulators. A Practical Handbook. By Sir DAVID SALOMONS, Bart., M.A., A.I.C.E. (New edition, revised and enlarged.) (London: Whittaker and Co.)

There can be no better test as to whether or not a book has met a general want than the number of editions which it runs through in a given time; and, judged by this standard, there are few works on matters electrical that have more thoroughly justified their existence than Sir David Salomons' practical little guide to the management of accumulators and electric-light installation. Since its first publication in 1886, no less than five editions of this work have appeared; it has been translated by the French and the Germans, and each new edition has been more bulky than the last, until a work which was originally nothing but a short pamphlet of 20 pages, dealing solely with the management of accumulators, has developed into a respectable-sized tome of over 300 pages, covering the whole subject of private installation work. Although to the electrical engineer the recent additions that have been made to this handbook have not enhanced its value in any considerable degree, yet, to that large class of readers who are desirous of obtaining a few practical hints on the installation and proper running of a private electric light plant, the enlargement of the second part of Sir David Salomons' book must prove very welcome.

That this volume should have met with such a gratifying reception as to necessitate a new edition on an average every year is not surprising when we remember how very much it stands alone. Of books giving the results of and conclusions drawn from laboratory tests we have enough and to spare; but up to the present the author of this little volume is nearly the only person who, having had a lengthy experience of the idiosyncracies of the modern storage cell when operated under ordinary everyday conditions, has made public the phenomena observed and the remedies adopted. Another reason for the success of this work is, we think, to be sought in the author's manner of presenting his facts. He has succeeded in avoiding the tedious minuteness of description so frequently met with in books of a semi-popular description, while at the same time he has not fallen into the error of the expert, who too often takes it for granted that his readers know as much about his particular subject as he does himself.

As the present edition is nearly double the size of its predecessor, it may be useful to note some of the more important additions. The first part, relating to storage cells, although of course it has not been enlarged to such an extent as that dealing with general installation work, contains, nevertheless, considerable new matter. Part II. has been augmented by two new chapters, those on "Alternating Currents" and "Testing," while all the old chapters have been largely added to, and the number of illustrations increased. The chapter on alternating currents deals with this subject in a very general way, and is mainly devoted to an explanation of Mr. Gisbert Kapp's ingenious regulating transformer, and to a somewhat disquieting list of the precautions to be taken in the case of a house connected to the mains of a transformer system. In Chapter VII. the necessity of making proper insulation tests is strongly insisted on; though the author's good advice is neutralised by his recommending the employment for this purpose of an "apparatus consisting of a high-resistance galvanometer of the Post Office

Digitized by Google

pattern, and a few portable Leclanché cells." With such a compact and practical piece of apparatus as the Goolden-Evershed ohmmeter (see *Electrician*, December 13, 1889) in the market, the use of the Leclanché cell for such tests should be a thing of the past.

In so widely read a work as the one we are considering, it is especially to be desired that there should be as few ambiguities or inaccuracies as possible; and we therefore trust that the few we have to notice will be eliminated in the sixth edition, which is no doubt already in hand. On page 278 we are told that "the effect of the successive reversals of magnetism in iron causes it to heat, and this phenomenon is termed hysteresis." The heating of the iron is certainly in part due to hysteresis; but it is *not* hysteresis, which cannot be better defined than, in the apt phraseology of Prof. Ewing, as "a tendency to persistence of previous magnetic state." The following statement on p. 281 also seems to us somewhat misleading: "If the apparatus were perfect, when the house is using no current the primary coil should likewise pass no current. This result is produced in consequence of the self-induction the apparatus possesses, and which acts like counter E.M.F., and the phenomenon is called 'impedance.'" The damming back of the current would more correctly be described as due to the "inductance" of the primary wire; since "impedance" is a *quantity* equal to $\sqrt{R^2+p^2L^2}$, and not in the usual acceptation of the word a phenomenon at all. We would also remark that the Board of Trade unit is 1,000 watt-hours, and not 1,000 watts as stated on p. 246.

These inaccuracies are pointed out in no spirit of captiousness, but, in a book so largely read by the amateur and the learner, ambiguities of expression are likely to give rise to confusion of ideas.

"The Electrician" Electrical Trades' Directory and Handbook for 1890. (*The Electrician* Printing and Publishing Company.)

The Electrical Trades' Directory and Handbook for 1890 is a volume whose merits cannot be fairly judged by mere inspection or even by careful examination of its contents. It is not until one has used it for several weeks that it is possible to compare it with previous issues. The Directory proper, occupying, as it does, about one-third of the volume, is clearly divided by coloured edges into four parts, and has not only been largely increased, to meet the growth of the industry, but the classifications have been carefully revised, and contain several references to the other portions of the book, *e.g.*, list of central stations.

The first third of the volume may fairly be described as an electrical Whitaker, and it merits this description, both on account of the value of its contents and of the accuracy of the compilation. A good deal of the information it contains, such as the tables of foreign import duties, and those showing the progress of lighting stations, tramways, lists of orders granted, and of notices of applications, would with difficulty be obtained elsewhere, while the tables of wire gauges, resistances, current densities, &c., are, as far as our habitual use of them has gone, in many respects preferable to those in the pocket-books, which are too large to be kept in the pocket, and too small to find among the papers which accumulate on most office tables. The Biographical Section has been enlarged, and eight new portraits have been added, besides the excellent steel engraving of Dr. Hopkinson. A. P. T.

Aide-Mémoire de l'Ingénieur-Electricien. By G. Duché, B. Marinovitch, E. Meylau, and G. Szarvady. Second Edition. Revised and enlarged by M. P. Juppont. (Paris: Bernard Tignol.)

It is, we believe, generally understood that the electrical engineer of the near future is to be a close approximation to omniscience; and the publication of pocket-books such as the above certainly points to this. In the "Aide-Mémoire de l'Ingénieur Électricien" is contained the whole theory and practice of electricity, with the addition of from 30 to 40 pages on Heat, Acoustics, and Optics. So exhaustive, indeed, is the information given, that it includes foreign money tables, data relating to the speed of horses, pigeons, and infantry soldiers, formula for the solution of triangles, &c., &c. The result of this attempt to cover so much ground is that many subjects of real use to the electrical engineer are either omitted altogether or unduly compressed. Transformers occupy some five pages, electric meters three pages, and the fifteen pages devoted to the subject of tests are mainly taken up with those of a laboratory character. Compression, not extension, should be aimed at in the next edition of this pocket-book.

Laxton's Price Book for 1890. (London: Kelly and Co.)

The contents of this well-known annual publication are quite up to the mark of previous years both as regards quality and quantity. In the small space allotted to electric lighting—seven pages last year and eight this—a considerable amount of useful information is to be found. We notice, however, one rather important mis-statement. In February, 1889, judgment was given by the Court of Appeal in favour of the Edison-Swan Company, so that it is somewhat erroneous to state in February, 1890, that "The cost of the incandescent lamps promises to be much reduced in consequence of the decision against the Edison-Swan Company as to its patents."

Annuaire pour l'an 1890, publié par le Bureau des Longitudes. (Paris: Gautnier-Villars et Fils).

The 1890 edition of the "Annuaire" is as replete as ever with valuable scientific information of all sorts. Some sixteen pages are devoted to tables of the magnetic elements for 1890, for various places in France and elsewhere, and in the eight pages allotted to electricity some useful data are given with respect to the E.M.F. of various voltaic and thermo-electric couples, and the resistance of metals and alloys. The "Annuaire," we may add, is now within measurable distance of its 100th anniversary, having been first published in 1796.

Electric Testing of Telegraph Cables. By Colonel V. Hoskiaer. (London: E. and F. N. Spon.) Third edition.

The third edition of Colonel Hoskiaer's valuable and much used guide to the art of practical cable testing has been both revised and enlarged. The typography, as well as the plates, are excellent, and the various tests are briefly and clearly described. We commend this little work to all who wish to obtain a good insight into the practice of cable testing.

Instructions for Fixing and Working Dynamo Electric Machines. By W. C. Mountain.

This is a little pamphlet of some 16 pages containing practical hints of the kind likely to prove of use to those who are left in charge of electric machinery without having had much previous experience of dynamos or motors.

RECALESCENCE AND DECALESCENCE.

Something less than a year ago, writes Mr. Robert Shand, in the *Electrical World* of March 8, a somewhat brief experimental investigation of the subject of recalescence was made by Prof. Elihu Thomson. New phenomena were then observed which meet to a considerable extent the suggestions made by Sir William Thomson on the occasion of the reading of Dr. J. Hopkinson's inaugural address at the Institution of Electrical Engineers. I will state my recollections on the subject.

While engaged in the early development of his now well-known method of welding by electricity, the attention of Prof. Thomson was strongly arrested by the magnitude of the recalescence phenomenon; it was then frequently pointed out by him, and the investigation above referred to was subsequently undertaken with the view of determining some of the changes undergone by the material at temperatures around the critical one at which the effect showed itself. The results of the investigation can be stated quite briefly, as follows:—

1. The temperature of *decalescnce* and the quantity of heat rendered latent during the heating of the material was found, within the range of observation, to bear a certain definite relation to its hardness, presumably to the percentage of combined carbon contained in it. The hardest specimen of steel submitted to observation possessed the highest critical temperature, and recalesced with most vigour. Softer specimens of steel

Digitized by Google

tested under the same conditions showed recalescence waves less in magnitude and occurring at lower temperatures. With soft iron bars the effect was not observed.

2. The temperature of *decalescence*, *i.e.*, the critical temperature at which the material *cooled* while heat was being supplied to it, was higher than the temperature of recalescence during cooling.

3. Heating the material from a point a little below, to one a little above, the critical temperature, and vibrating the temperature thus many times in succession, seemed to induce in the material a condition of exhaustion; at any rate, the magnitude of the phenomenon was lessened by such treatment. Allowing the material to cool off, or raising the temperature considerably above the critical point, restored to the material the power of vigorous recalescence.

It would be exceedingly interesting in this relation to ascertain by measurements, closer than were possible with the apparatus constructed by Prof. Thomson, whether or not it is possible that the same piece of steel, at the same temperature before and after recalescence, can exist in two different states as regards its capacity for magnetisation.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

ALTERNATING v. CONTINUOUS CURRENTS IN RELATION TO THE HUMAN BODY.*

By H. Newman Lawrence, Member, and Arthur Harries, M.D.

Much attention has lately been drawn, both in England and America, but especially in the latter country, to the dangers to which workmen and others are exposed when handling and working with wires, dynamos, and other apparatus connected with the generation and supply of electric currents for light and power. A lively controversy regarding the relative safety of continuous or alternating currents has resulted; but little, if anything, has been done to throw direct light upon the matter, and great difficulty is, therefore, experienced by disinterested persons in arriving at a satisfactory conclusion. It is with great diffidence that we venture to offer this short Paper on the subject, as the experiments and observations upon which our contribution is based were not specially undertaken with the object of throwing light upon it. They form part of a series of data connected with investigations upon which we are engaged with the hope of solving some of the physiological problems occurring in the course of our electro-therapeutic work at the Institute of Medical Electricity. The results obtained from some of our experiments (hereinafter given in detail) led us to note how strongly they bore on the question now before us. We, therefore, after verifying them by repetion, thought it well to invite discussion upon them, and now offer them for your consideration, with full consciousness of their imperfection. They differ from the experiments of D'Arsonval, Harold P. Browne, and others, in the important point that they deal, not with the bodies of rabbits, dogs, and horses, or other animals (from which conclusions regarding human life have to be evolved), but directly with the human body. We do not in any way propose to touch upon the question of the manner in which accidents with electric wires, &c., occur, or how they they may be prevented. It would be manifestly beyond our province to do so. Our object is rather to compare the physiological action of the two forms of current *after the contact*, accidental or otherwise, has been made, and to arrive at some conclusion as to the danger ratio which one form of current may bear to the other under such conditions.

As may already have been gleaned, our experiments have not been made with the powerful currents dealt with in electric lighting and distribution of power. We used small currents, for the most part at low E.M.F., and have directed our attention to—

1st. The determination of the resistance of the human body and skin to the passage of currents under certain conditions; and,

2nd. A comparison of the sensations produced in the human body by passage of the two forms of current.

1st. With regard to the resistance of the human body and skin. In his Lumleian Lectures, delivered before the Royal College of Physicians in April, 1886, Dr. W. H. Stone gave some very useful information. His experiments appear to have been carried out with care, and the results, therefore, are reliable. In the course of many similar experiments we find no reason to differ in the main from the figures he has arrived at, and we quote those that refer to our immediate subject in the following table:—

* Paper read March 27, 1890.

Table A.

—	Resistance, Foot to Foot.	Resistance, Foot to Hand.
Mr. T.	945 ohms	1,320 ohms
Mr. S.	930 „	1,027 „
Hungarian Giant	930 „	1,032 „

There is, however, this important fact to be taken into account, when considering the bearing which these figures have on the present question, viz.—that Dr. Stone, having a direct therapeutic object in view, was dealing (as far as he could) with the internal resistance of the body, and not with its total resistance as represented by that of internal tissues and skin in its normal insulating condition. Further, Dr. Stone's experiments were scarcely typical of results to be expected from either purely continuous or purely alternating currents; for in his lecture he says, with reference to the experiments quoted in Table A, that he had in "circuit a Wheatstone bridge of a rather particular form, a commutating key so as to send the current in opposite directions, &c."

Some experiments conducted by Mr. William Lant Carpenter, however, are more in accordance with the conditions which this Paper is intended to illustrate, as they enable us to form some clear idea of the nature of the current actually used.

The results of these experiments, published in August, September, and October, 1883, in *Health*, are shown in

Table B.—*Continuous Currents.*

—	Resistance from Foot to Foot, in Ohms.	—	Resistance from Foot to Foot, in Ohms.
Dry skin	— min. 10,300	Salt and water...	30 min. 1,400
Salt and water	1 „ 4,300	„ ...	35 „ 1,290
„ ...	5 „ 2,500	„ ...	40 „ 1,250
„ ...	7 „ 2,100	„ ...	45 „ 1,230
„ ...	10 „ 1,900	„ ...	50 „ 1,200
„ ...	15 „ 1,720	„ ...	60 „ 1,190
„ ...	20 „ 1,540		to 1,200
„ ...	25 „ 1,470		

Our own experiments have been made with the skin *normally dry* and *moist*, and we have selected measurements taken from hand to hand, as the hands are the parts most likely to come into contact with wires and other conductors.

The first series of readings are those of resistance to continuous current. They were taken by the ordinary Wheatstone bridge method with a mirror galvanometer. Tin electrodes, each of 50 sq. cm. area, were used, the extended palms being placed upon the electrodes.

The results are shown in

Table C.—*Resistance to Continuous Currents.*

Subject.	Age about	Dry.	Moist with Distilled Water.	Moist with Salt Water.
	Years.	Ohms.	Ohms.	Ohms.
1	35	39,000	19,700	9,170
2	22	49.000	7,700	5,900
3	35	41,400	23,000	11,000
4	38	40,000	11,500	5,900
5	35	50,000	9,500	5,900
6	40	45,000	30,400	26,400
7	21	19,000	7,600	6,700
8	22	27,000	25,400	12,000
9	26	31,000	7,000	6,500
10	24	40,000	10,700	7,000

In estimating the measurement of resistance to the continuous current we must remember that, as the result of the almost instantaneous congestion which follows the closing of the circuit, *resistance is to a certain extent diminished*. Very shortly this is succeeded by polarisation, and by the conditions which accompany the conversion of the body into a secondary battery, and there is consequently a considerable increase in resistance when the passage of current is continued for an appreciable time. On the other hand, the passage of alternating currents is accompanied by a diminishing resistance from the outset, for the early physiological congestion is followed neither by polarisation nor by the electrolytic action which it is usual to expect when the continuous current is used. Table D shows the resistance to alternating currents of the same ten people taken with the same electrodes on the same occasion as those referred to in Table C.

Digitized by Google

TABLE D.—*Alternating Currents.*

Subject.	Dry.	Moist with Distilled Water.	Moist with Salt Water.
	Ohms.	Ohms.	Ohms.
1	2,900	2,500	1,500
2	10,400	1,800	1,200
3	5.500	1,600	1,600
4	2,500	2,200	1,200
5	5,400	1,600	1,500
6	2,600	1,700	1,300
7	1,400	1,450	1,250
8	2,350	1,500	1,400
9	3,500	1,500	1,600
10	5,000	1,375	1,500

Tables C and D are fairly comparable as regards the same individuals, though the maximal differences are strongly marked.

Dr. Stone, in his lecture above referred to, mentioned a very important fact, which since appears to have been overlooked, viz., that (under the conditions he adopted) the resistance of the human body was only about half as great for alternating currents as for the continuous current. This statement we have never seen questioned, and our own experiments show that, under conditions more assimilating to those likely to occur in practical work, the proportion is considerably greater. Table D shows wide variations in the resistance of the individuals tested, as well as other peculiarities which are no doubt partly due to errors of observation, but more largely due to physiological conditions which are scarcely relevant to this Paper; but the tremendous difference between the resistance to alternating currents and the resistance to the continuous current is clearly and definitely marked, and justifies us in drawing certain conclusions therefrom. We find the :—

	Ohms.
Average resistance to the continuous current, moist with salt and water	9,557
" " " alternating " " " "	1,405
" " " continuous " " distilled "	15,250
" " " alternating " " " "	1,722
" " " continuous " dry	38,140
" " " alternating " "	4,155

This difference is illustrated in the comparative-resistance diagram (Fig. 1).

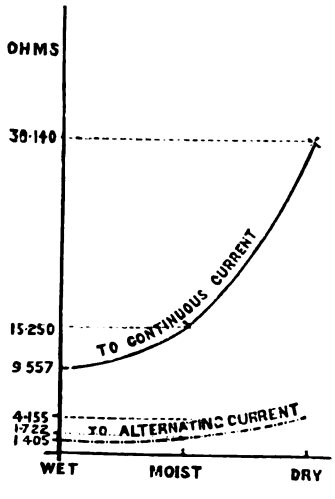


FIG. 1.

When this condition of things became apparent we thought it well to confirm our experiments by repeating them as far as possible under conditions such as would occur in actual working. The results of this set of control experiments we give in Table E. The ten persons tested were chosen so as to be, as far as possible, representatives of those likely to come in contact with electric light and power wires and other conductors. Five were workmen with hands hardened and rendered by toil, as far as may be, insensitive to electric currents. The other five were men accustomed to brain work, and may be taken as representing the occupiers of houses likely to use the electric light, and occasionally to come into contact with the leads, terminals, lamps, &c., of house installations. The electrodes used were of plain metal, and could be grasped in the hand, and so may be taken to represent the metal about a dynamo, or a bare wire or other conductor, which might be grasped accidentally by a workman occupied about a lighting or power station, or by a gentleman investigating some electrical irregularity in his own house. The continuous-current tests were made with a Wheatstone bridge of Post Office pattern, and a mirror galvanometer. The alternating-current tests were made with one of Kohlrausch's rheometers, in which the balance is observed through a telephone. The alternating currents obtained from the induction coil of the instrument had a periodic frequency of about 300 per second. The dry readings were taken with normally dry hands. The moist readings were taken after the hands had been dipped into ordinary tap water.

TABLE E.

Subject.	Resistance in Ohms.			
	Dry Hands.		Moistened Hands.	
	C.C.	A.C.	C.C.	A.C.
1	36,000	2,200	25,000	1,450
2	17,000	1,850	9,000	1,400
3	7,000	1,800	6,400	1,600
4	12,000	1,400	5,900	1,275
5	18,900	1,600	14,700	1,450
6	8,400	1,450	3,900	1,200
7	10,450	1,000	7,500	1,300
8	8,500	1,500	7,300	1,450
9	14,300	2,000	10,900	1,600
10	12,200	1,900	6,900	1,650
Average.....	14,475	1,740	9,750	1,437

These results indicate that the resistance of the human body to continuous current is 6·8 *times* greater than it is to alternating currents when the skin is moistened, and 8·3 times greater when the skin is in its normal condition and not moistened by artificial means. Starting with the statement of Dr. Stone that when the skin has been well soaked with a conducting fluid, and electrodes of large area are used, so that little, if any, more than the internal resistance of the body comes under observation, the resistance to the continuous current is nearly double that to alternating currents (*The Electrician*, April 23, 1886, p. 480), we find that the ratio increases conversely with the moisture of the skin, till in the normal condition we reach the maximum of 9·1 for contact of small area, and 8·3 for contact obtained under ordinary working conditions.

We now come to the second part of our subject, viz. : A comparison of the sensations produced in the body by the passage of the two forms of current. The sensitiveness of persons to the continuous current varies very much, quite independently of variation of resistance. But we find that most people (and we have tested some hundreds) can bear without discomfort the passage of 10 milliamperes for a short time ; and therefore, for the purposes of this Paper, we will consider that amount of current strength as the maximum which may be passed through the body without producing unpleasant sensations. With alternating currents, however, a very different state of things is disclosed ; for having in the course of our therapeutic work found the great need for accurately measuring the alternating currents from induction coils, we obtained from Germany (after failing to find a suitable instrument of English make) a galvanometer recording milliamperes of alternating currents, and, on putting it in circuit with a patient, were surprised to note that before the needle indicated the passage of a single milliampere the patient complained that the current was too strong, and practically unbearable. This, of course, led to further investigation, with the result that, though we tested a large number of persons of varied ages and of both sexes, we found only a few who could bear with comfort the passage of one milliampere of alternating currents.

Table F shows the result of sensation tests made upon the ten subjects above referred to.

TABLE F.—*Sensation Tests.*

Subject.	Without Discomfort.		Muscular Fixation.
	C.C.	A.C.	A.C.
	Ma.	Ma.	Ma.
1	10·0	2·0	4·5
2	10·0	2·0	3·0
3	10·0	2·5	3·75
4	10·0	1·0	2·75
5	10·0	1·0	2·0
6	10·0	2·0	3·25
7	10·0	2·5	6·0
8	10·0	2·0	4·5
9	10·0	1·0	2·25
10	10·0	1·0	4·0
Average.	10·0	1·7	3·6

[Experimental sensation tests were here shown.]

Digitized by Google

So far, we seem to be justified in putting the limit for alternating currents at two milliamperes, and we wish it to be understood that any advance upon this limit means extreme discomfort. Beyond that point violent muscular contraction, rendering relaxation of grasp first difficult, and then impossible, produces distinct pain, which agitates the whole body. We can therefore confidently state that, as far as sensations are concerned, the human body can bear with ease at least five times as much of continuous-current strength as of alternating-current strength. When this fact is taken in connection with the great difference in the resistance offered by the body to the two forms of current, it leads to the conclusion that the danger of unpleasant consequences, and possibly (if not probably) of loss of life when currents of equal voltage are handled, is 34 times ($6{\cdot}8 \times 5$) greater with moist hands, and 41·5 times ($8{\cdot}3 \times 5$) greater with dry hands, when alternating currents are used than when the continuous current is employed. These figures we will adopt as representing the *danger-ratio*.

As a practical example of this conclusion we may take the Board of Trade limit of pressure at which currents may enter houses, viz., 200 volts, and assume that a man having the average resistance taken from Table E handles naked wires within the house.

$$\text{With the continuous current (dry hands)} \Big\} C = \frac{200}{14{,}475} = 13{\cdot}5 \text{ milliamperes.}$$

He thus receives only 13·5 milliamperes, which is little more than, as shown above, he can take with perfect impunity.

$$\text{With alternating currents (dry hands)} \Big\} C = \frac{200}{1{,}740} = 115 \text{ milliamperes.}$$

He thus receives 57 *times more current* than he can bear without discomfort, and the danger of physiological shock is correspondingly increased.

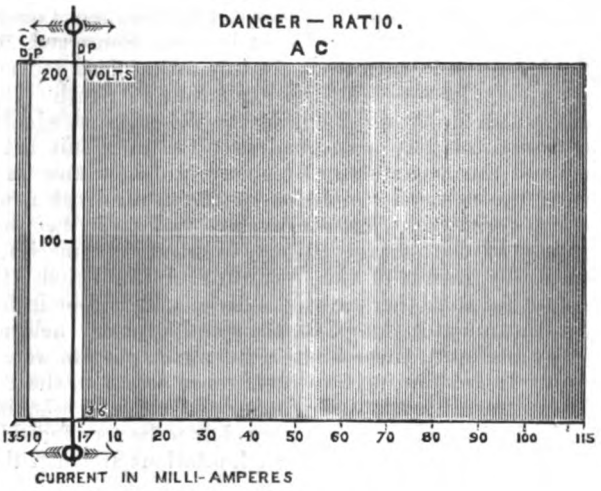


FIG. 2.

The total area on the left side of line O illustrates the amount of *continuous* current (C C) at 200 volts pressure, which will pass through a man making contact with *normally dry hands*. The area on the right of line O shows the amount of *alternating* currents which will pass under same conditions. The plain area on each side shows how much of such currents lie on the *safe side* of discomfort point (D. P.), while the shaded portion shows what lies on the *unsafe* side of D. P. A comparison of the two shaded areas expresses the danger ratio.

Fig. 2 diagrammatically illustrates this danger-ratio. It may be objected that all this has little relevancy when large currents of either kind at high potentials, have to be dealt with; but we would submit that what we have proved to be the case with small currents and low potentials may be fairly taken to be intensified as the current strength and E.M.F. increase. There is at present no reason to suppose that the ratio of resistance diminishes, or that of the sensations becomes lessened, though it may possibly happen that with increased current strength or higher potential the absolute resistance may vary.

What the minimum current of either kind which will destroy human life may be, we are not in a position to say; though D'Arsonval, in his report on electro-physiology made before the International Congress of Electricians held at Paris, 1889 (*The Electrician*, August 30, 1889), says, referring to his experiments on rabbits, guinea pigs, and dogs:—"With a machine of 8,000 volts a momentary closing of the current caused the animal (a rabbit) to make a prodigious leap, but did not cause death immediately; a second application was necessary." "An alternating Gramme machine only causes death above 120 volts mean potential." These statements are not very clear, but we gather therefrom that while a continuous current machine having an E.M.F. of 8,000 volts did *not* instantly kill a rabbit, yet an alternating-current machine having a mean potential of 120 volts did. We feel sure that no hard-and-fast lines can be laid down on the subject. *Individual resistance and individual sensitiveness vary so much and so unexpectedly* that a current which might be taken with impunity by one person might be more than enough to kill another.

With regard to danger ratio, D'Arsonval seems to more than bear out the conclusions that we have arrived at, though he gives no information as to the current strength used. Independently of the kind of current used, the character of the contact made, the surface area of the body involved, and the suddenness of closing or opening the circuit must each and all play an important part in the result. Shock varies with the form of current employed: thus with continuous current only a "make" initial shock is possible, while with alternating currents the initial shock may be either a "make" or a "break" shock. As "break" shock is admitted to be the more marked of the two, independently of the steady diminution of resistance to alternating current, it is probable that the effects of an initial shock with alternating currents of similar strength may be more disastrous than that with continuous current.

DISCUSSION. (AUTHORISED ABSTRACT.)

Prof. FORBES said that although the comparisons of the effects of alternating and continuous current were very interesting, the tests made and the results obtained had little bearing on the practical question of safety in the use of electricity for lighting and power purposes; for the conclusions arrived at in the Paper were not in accord with actual experience. He was willing to admit that he could not bear so many volts alternating as those continuous; but the difference was comparatively small, certainly nothing like so great as the authors would have him believe. The sensations, he said, depended not on the mean current, but on the maximum value of the current or volts, and in the case of an induction coil the volts on break were immensely greater (20 to 50 times) than the minimum occurring in a well-designed alternator, which would send the same mean current through the body as that indicated by the measuring instrument used.

Mr. KAPP concurred in Prof. Forbes's views as to the great difference existing between the conditions under which the experiments were made and those occurring in practice as regarded alternating currents. From experiments he had tried himself, he found he could bear 100 volts continuous with about the same discomfort as 40 volts alternating.

Major CARDEW agreed with Prof. Forbes's statement about the much greater maxima obtained with induction coils than with alternating machines, and said that great differences existed in the shocks received from different machines, even when the measured volts were the same. For example, shocks received from old Wilde machines were very severe, even when the volts were small; he had known a man to be nearly killed by a 300-volt machine of that type, whilst from a modern alternator 100 volts might be taken without great discomfort. Speaking of the resistance tests in Table E, he remarked on the great differences in the resistance of individuals to alternating and continuous currents, and on the disproportionality between them; these differences he believed due to polarisation of the electrolytes in the body. As regarded sensations, he had reason to think that the effect of a given current depended on the volts employed to send the current. Referring to the Board of Trade regulations, he informed the authors that permission to use 200 volts alternating on consumers' circuits had never been granted.

Dr. STEVENSON agreed with the last speaker as to the current from a large battery producing more powerful sensations than an equal current from a smaller number of cells.

Mr. SAYERS thought sensation depended greatly on the shape of the E.M.F. curve and on the frequency of alternation.

Mr. WYLES said he once saw a man come into contact with a Brush 35-lighter; fortunately, he fell away from the machine, and the only after effect was a pain across the chest.

Mr. E. T. CARTER asked whether the resistances to continuous currents were all obtained with the same current strength, or whether various strengths were used in each case, for if there was polarisation, resistance would vary with current. He also inquired if the effects of purely transient currents, such as discharges from cables, and of electrostatic capacity, had been investigated; and asked what was the effect of alternating currents of frequencies less than 300 per second.

Mr. CROMPTON said he had recently tested the resistances of individuals by Evershed's ohmmeter, 100 volts being used in all cases. As a rule he found the resistance to fall from 30,000 or 40,000 to 25,000, by continued application, and in some cases 10,000 or 11,000 ohms were indicated. Children usually gave 8,000 to 10,000. One person whose wrist had recently been subjected to a surgical operation gave a resistance of 25,000 from hand to hand, but on placing one electrode on the part operated on, the resistance fell to 14,000. The sensation effects varied greatly in different individuals, for some whose resistances were 30,000 experienced much greater discomfort than children with 10,000 ohms resistance. As to alternating currents, he believed that there was a general concensus of opinion that only about half as many alternating as direct volts could be borne. Some time ago he, in conjunction with Colonel Armstrong, had made experiments to see what current one could bear, and they found that at 15 milliamperes the skin below the electrodes became hot, whilst at 35 milliamperes the skin was scorched in a few seconds.

Mr. F. H. NALDER suggested that the differences between the resistances with wet and dry hands might be due to surface leakage.

Mr. JOYCE said that, even if they admitted the difference in the E.M.F. curves of induction coils and alternators in producing sensations, as

Digitized by Google

pointed out by Prof. Forbes, yet from Table E one could see that there was a great difference between the resistances of the body to alternating and continuous currents. This of itself meant a serious difference in the "danger ratio."

Mr. W. H. PREECE believed there had been more nonsense talked about that subject, particularly on the other side of the Atlantic, than on any other with which he was acquainted; and they were indebted to the author for clearing the ground a little. He himself had had the misfortune to receive the discharge from a Leyden jar and to be transfixed to a 2,000-volt Brush machine. He was also in the habit of receiving shocks from continuous currents of about 25 milliamperes without experiencing as much unpleasantness as he had just felt with a current of two milliamperes from the induction coil. This led him to inquire whether the instrument used to measure the latter current was accurate. Quite recently he had received an account of an accident whereby a man was subjected to a shock from a 1,200-volt circuit; his fingers were burned, and he was rendered insensible for 10 minutes. Speaking of the so-called "dangers of electricity," he said the difficulty was to kill, rather than to prevent being killed, and that the question was not one of high or low potentials or alternating *v.* continuous currents, but of overhead *v.* underground mains, and bad or good workmanship and insulation. In his opinion it should be impossible for any one to accidentally come into contact with house circuits.

Dr. HARRIES said he had anticipated more discussion on the physiological points raised. Referring to Prof. Forbes' views, he remarked that the high voltage on breaks meant little if the resistance was high. In reply to Major Cardew, he said the differences in resistance depended entirely on the normal state of the skin, and that polarisation did not play an important part, for in the continuous-current experiments the contacts were instantaneous. As regarded the effect of frequency, he stated that the greater the frequency the less unpleasant a given current became. Mr. Crompton's results in the main confirmed their own, but had thrown doubt on the polarisation effect. However, Dr. Stone had shown that it existed, and the first fall of resistance was accounted for by the congestion of the part touched.

Replying to the electrical points, Mr. LAWRENCE said the frequency of the alternating currents was about the same in all the experiments, and that from greater frequencies he would expect less effect. As to the accuracy of the milliampere meter, he said he would be glad to have it tested by anyone interested. They themselves had had it tried by an experienced firm, who reported it to be within 5 per cent.

Mr. ALEX. SIEMENS (who was in the chair), in proposing a vote of thanks to the authors, said they had heard a great deal about the dangers of electricity, but nothing about its beneficial applications. He himself had experienced its pain-alleviating properties in the case of teeth extraction. The positive terminal of a battery was held in the hand and the negative attached to the forceps, and the pain was very slight compared to that experienced in the ordinary methods of extraction. The effect, he believed, was due to the nerve being cauterised by the current; and he suggested to medical men the question whether some such methods could not be adopted with advantage in amputations and other surgical operations.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *March* 22, 1890.

Alternating-Current Apparatus.—There is just now no little interest here concerning alternating current apparatus. A great deal has been said, but very little is known, concerning its actual practical efficiency. In a Paper read last Tuesday evening before the Institute of Electrical Engineers, Dr. Louis Duncan, of Johns Hopkins University, Baltimore, gave a most interesting account of some definite tests made on Westinghouse alternating apparatus of various modes and under various conditions. The points which Dr. Duncan brought out were, in the first place, that the efficiency at full load of alternating apparatus is hardly as great as has been oftentimes claimed for it. The efficiency secured in the tests which he made on a 750-light Westinghouse incandescent dynamo was a trifle under 80 per cent. The largest loss in this case seemed to be the loss in the armature core. The mechanical friction of the machine did not seem to be high, but the magnetic friction, so to speak, was so great as to lower the efficiency of the machine very distinctly. The converters used were the ordinary Westinghouse type, and at full load gave an efficiency of nearly 95 per cent. This efficiency, however, rapidly fell off as the load was lightened. Under ordinary conditions of load the efficiency of the system would be less than 70 per cent. It should be remembered, however, that for the class of work for which that system is used, 70 per cent. is perhaps as high an efficiency as could be obtained from any other system. In attempting to forecast the future of the alternating system, Dr. Duncan expressed himself strongly in favour of large converters operating a considerable number of lights, so that the average load might more nearly approximate to the most economical load. Comparing the alternating and direct systems, Dr. Duncan said that, in his opinion, at the present the greatest average economy would be obtained by combining the two systems, operating the lamps in the compact district near the station by the direct system, and operating the outlying lamps distant from the station by the alternating system. The paper provoked a spirited discussion, in which Mr. Nikola Tesla took a prominent part. Mr. Tesla thought that more recent alternating apparatus than that tested by Dr. Duncan would give more favourable results for the average efficiency.

Storage Battery Decision.—An important decision has just been rendered by Judge Coxe, of the United States District Court, in the infringement suit between the Brush Electric Company and the Julien Company. This suit has been pending for some time, and, before the decision was rendered, the Julien Company obtained an option on the right to become licensees of the Brush Company; the option to remain in force 48 hours after the granting of the decree following the decision. The decision, which is a very voluminous one, is emphatic in favour of and sustains the broad claim of the Brush Company to a storage battery wherein the active material is applied to the plates by mechanical means of whatever kind. Pending this decision the Julien Company have been keeping very quiet, but now are reported as proposing to begin active operations at once under the Brush patent. With this decision, the storage-battery fight is left practically between the Brush Company and the Electrical Accumulator Company, and narrows itself down to a duel between Faure and Brush on the invention in question. An interesting flank movement may possibly be based on the expiration of Brush's Italian patent, which is precisely similar to the ones on which the present decision has been rendered; for in a suit between Brush and the Accumulator Company, which is now in progress, if the decision should be in favour of Brush it would practically give the Brush Company and their licensees a monopoly of the storage battery business in America. If, however, by reason of the expiration of the Brush Italian patent, or for any other cause, the decision should be in favour of the Accumulator Company, the storage-battery field would be left quite open, since Faure's American patents were considerably limited during the interference action in the Patent Office between Brush and Faure. In other words, if the Brush patent is upheld, it is so broad as to be very formidable. If the Faure patent is upheld, its limitations are such that it would be no serious obstacle.

An Alternating Arc System.—Considerable attention is just now attracted to the Westinghouse Alternating Arc System, which is now in use on a practical scale in this city. Its details have not yet been made public, although 125 lights of this system are scattered along the Bowery, and have been giving general satisfaction. As is already known from the advertisements of the Westinghouse Company, it is a series-transformer system, each arc lamp being worked on an independent transformer. The lamps are of 2,000 candle-power, each requiring 10 amperes and 50 volts between the terminals of the lamp. This current is derived from a primary current of 30 amperes on the line, so that the transformation is to increase instead of to diminish the voltage. The Westinghouse Company claim greatly increased light for the carbons under this system. By the use of a flat carbon 2¼in. wide, each carbon being about eight inches long, the Company has been enabled to secure 44 hours' continuous burning, while a ½in. round carbon of the same length gave about 13 hours. As there is no crater formed by the arc, the distribution of light promises to be more even than in ordinary arc lamps. Of course, it will take some time to determine the real merits of the system, but it seems decidedly promising, and on the score of safety is certainly to be desired; since, unless the primary current should break through into the transformer, which is a very unlikely occurrence, the arc lamp may be handled with perfect impunity, save for a possibility of burning one's fingers. The lamp is actually in use, burns

Digitized by Google

with a clear, steady, brilliant light, and has proved so satisfactory that two more circuits, each with 125 arc lamps, will soon be supplied.

Motors.—Just now there seems to be greater activity in the motor field than usual. Nearly all the leading companies report large contracts, and are behind their orders. With the coming of spring, construction will begin actively on a number of new railroads, and activity in that field seems to be specially great. The Julien Company are promising to push their storage system rapidly to the front. There is certainly a great field for it, or any other successful storage system, in this city. And they promise, too, to make experiments in the way of using storage-battery cars on the elevated railroads. It is hard to see the need of them in this particular place, where direct supply can be so advantageously used. There seems to be no little public interest excited in the possibility of electric elevated roads, and the chances are that the many suggestions in this direction will lead to some practical results in the near future.

CORRESPONDENCE.

ALTERNATE *v.* CONTINUOUS CURRENTS IN RELATION TO THE HUMAN BODY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your next issue you will probably publish the Paper read last Thursday before the Institution of Electrical Engineers, by Messrs. Harries and Lawrence, comparing the physiological effects of continuous and alternating currents.

As an example of their experiments, a continuous current of 10 milliamperes was passed through the human body without discomfort, and then the alternating current from the secondary of an induction coil (which is a discontinuous current) produced great discomfort when the instrument employed measured two or three milliamperes.

It is only fair that the principal fallacy of their conclusions should be shown at the same time that your journal goes forth to the world disseminating the error.

The instrument employed measures the "effective" current (a kind of average over the period of an alternation). The discomfort, however, measures the *maximum* value of the current during an alternation. With a well-made alternating dynamo the maximum current is about one and a-half times the effective current. But with the discontinuous secondary current, obtained by breaking the primary circuit of an induction coil, the maximum current rises to many times (I estimate 20 to 50 times) the effective current. Thus, the current which caused discomfort was probably 20 to 50 times the current which was measured.—Yours, &c.,

GEORGE FORBES.

34, Great George-street, Westminster, S.W.,
March 31, 1890.

SINGLE *v.* DOUBLE MOTORS FOR ELECTRIC CARS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of January 3, 1890, appeared a reprint of an article contributed by me to the *Electrical World* of this city. Permit me to return to one of the relations set forth in that article. It was shown that under the usual conditions of street-car service in this country, it may be said that one electrical horse-power-hour in the station will effect one car-mile of service on the tracks. This statement refers to a sixteen-foot car, carrying two motors, which, with gearing and switches, weighs from 3,000 to 4,000 pounds.

In your editorial comment, you quite justly referred to the fact that this relation of car-mile and horse-power-hour, as well as several others brought out in my Paper, were founded on data insufficient to establish perfectly accurate values. I have lately been permitted to see the results of a series of tests, more extensive than those reported by me, which confirm my statement as being a fairly good guide for average existing conditions. But in one important particular I think present practice will, ere long, be modified. Instead of two motors on a car, it is probable that only one will be used; and should this change be made, I believe that, *cet. par.*, we might write: 1 E.H.P. hour = 1·25 car-mile.

During the time that I was superintendent of the Sprague Electric Railway and Motor Company (which was the time of development of their railway machinery), it was "borne in upon me," and for reasons too numerous here to mention, that the single-motor method was the better. Yet I was surprised to learn a few days ago that there is, according to some recent tests, a very large saving in the power required for moving a given load, as well as the saving in initial expense, in wear and tear, and in attendance. That there should be some saving of power follows from the fact of taking out one set of reducing gear and motor. But the tests referred to indicate that either this saving is greater than one would ordinarily calculate, or that there is an unforeseen electrical as well as mechanical loss, due to working two series motors in multiple with each other and connected to the axles through gearing in a way now commonly understood.

I regret that I cannot at this writing reach the engineer who made the tests and obtain his permission to give the particulars of his work. I write this to indicate, before its exact value can be had, the nature of a probable correction to a formula quite useful for hasty calculation.

It is, of course, not an easy problem to connect one motor with both axles; but it is desirable, and possible.—Yours, &c.,

O. T. CROSBY.

Room 322, Potter Building, New York City,
March 16, 1890.

DYNAMO AND MOTOR DESIGN.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The so-called "Authorised Abstract" of the discussion on the above subject which you publish on pages 526-530 (*The Electrician*, March 28th), in so far as reference is made to my remarks, is incomplete and misleading. I trust, therefore, you will allow me space to briefly state the true purport of what I said in reference to the action of the convolutions being commutated; and also in reference to the effect of the lamination of the core in decreasing the divergence between generator and motor. I pointed out that when a wasteful current is generated in the short-circuited coils, this current is obviously of the same direction as the Foucault currents in the iron core, and consequently opposes the motion whether the machine is running as a generator or as a motor, and that it could never assist in the case of a motor, as Mr. Swinburne says it does in his Paper (*The Electrician*, February 21st, p. 401). I then pointed out that these currents and the Foucault currents in the core decrease the magnetic flux in the case of a generator, and increase it in the case of a motor, and that these two actions account for the observed divergences in the E.M.F. generated in the armature winding in the two cases. When there is no wasteful current in the short-circuited coil (which is the case in a good machine with brushes in the position of non-sparking), and the core of the armature is well laminated and insulated, the divergence between generator and motor is reduced to a minimum, and is very small.

From the above it appears that not only is the best possible generator the best possible motor, but that the better the machine the less is the divergence from complete reversibility.—Yours, &c.,

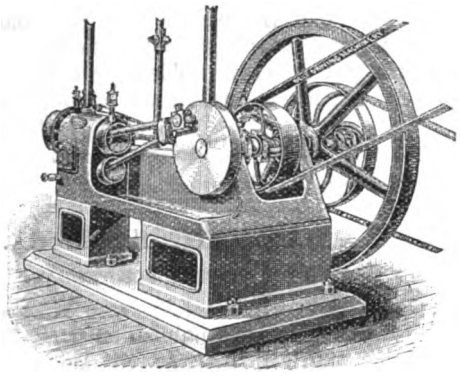
W. B. SAYERS.

Gutta-percha-covered Wires in Cement Conduits.—In an article in the *Annales Telégraphiques*, M. Scheffer, in describing the repairs which he has lately been carrying out on the subterranean lines in Maurienne (Savoy), calls attention to the deterioration of the gutta-percha insulation of wires laid in cement conduits. "The gutta-percha is in most instances impaired, and in consequence the thickness of the dielectric is no longer sufficient to prevent disruptive discharges where high-tension currents are employed." The wires in question were laid in 1885.

Digitized by Google

THE "FAWCETT" GAS ENGINE.

The gas engine shown in the annexed illustration is manufactured by Messrs. Fawcett and Co., of Liverpool and London. The chief object in view has been to construct it with as few moving parts as possible, so as to reduce the liability of getting out of order. There are no geared wheels, side shaft, cams, nor clack valves. The whole of the motion work consists only of a slide valve and an exhaust valve, both of which are actuated by one eccentric, as in an ordinary steam engine. The cycle is as follows:—The piston of the compression cylinder on its outward stroke draws a charge of gas and air, and on its return stroke forces the mixed gases into the power cylinder, at the same time driving out half of the waste gases, whilst the returning piston of the power cylinder drives out the remaining waste gases. These operations take place during about half the instroke of the power cylinder piston, when the exhaust is closed, and the compression of the gases is completed during the remaining instroke of the two pistons. The charge is then fired, and the power imparted to the crank shaft in the usual way. It will thus be seen that there is an explosion at each revolution of the engine, and, by an ingenious arrangement of the governor, the force of the explosion and the quantity of gas used is proportioned to the load upon the engine. This engine is thus very suitable for working electric light or other machinery where absolutely steady driving is required.



The following figures are from a test by Mr. T. L. Miller, Assoc.M.Inst.C.E., M.Inst.M.E., consulting engineer, Liverpool, of a 6 horse-power nominal Fawcett gas engine :—

Motor cylinder, 8in. diameter, by 15 $\frac{15}{16}$ stroke.
Compression cylinder, 6$\frac{1}{2}$in. diameter, by 15$\frac{15}{16}$ stroke.
Total gas used, 210·8 cubic feet per hour.
Revolutions, 150·8 per minute.
Indicated horse-power, 11·49 net.
Brake horse-power, 8·52.
Gas per indicated horse-power per hour (main only), 18·4 cubic feet.
Gas per brake horse-power per hour (main only), 24·74 cubic feet.
Mechanical efficiency, ·741.

PARIS ELECTRIC METER COMPETITION, 1890.

The following regulations have been issued for the electric meter competition, inaugurated this year by the Paris Municipal Council :—

1. The competition is open to all inventors of electric meters, for use with continuous currents, alternate currents, or both.

2. The apparatus sent in may be either coulomb-meters or watt-meters.

3. The meter must be direct-reading, and the consumer should be able to ascertain for himself the amount of current consumed.

4. The meters must register small currents : coulomb-meters should act when only ·2 ampere passes ; watt-meters should act for a consumption of 20 watts.

5. The meters, accompanied by a description, must be sent under a sealed cover to the office of the Sub-Director of Works, at the Hôtel de Ville, before the 31st of August next.

6. The meters sent in will be submitted to a committee composed of nine members, five of whom will be appointed by the Municipal Council, and four by the Administration.

7. The apparatus will be submitted to comparative tests as to accuracy throughout the whole of their range, practical efficiency (regularity of working, simplicity, cost, &c.), energy absorbed in working, and disturbance occasioned by their use in a system of distribution.

8. A sum of 13,000fr. will be distributed as follows :—10,000fr. to the inventor who produces a meter giving complete satisfaction and equally applicable to alternate or continuous currents. If the meter is only applicable to one of the two kinds of current, the inventor will only be entitled to half the premium. Premiums not exceeding 2,000fr. will be awarded to those meters designed both for continuous and alternate currents, and 1,000fr. to those meters suitable only for one kind of current which show the greatest advances.

TRADE NOTES AND NOTICES.

TENDERS INVITED.—*Extension of Time.*—Notice is given that the time for sending in tenders for the several sections of the Brighton Corporation Electric Lighting Works has been extended to the 16th day of April, 1890, at 11 o'clock.

TEMPORARY REMOVAL NOTICE.—Messrs. E. L. Berry and Co., electrical engineers and contractors, late of 8, Wardour-street, have taken temporary premises at No. 45, Gerard-street, Wardour-street, during the completion of their new premises.

MESSRS. MARSHALL, SONS, AND CO. (LIMITED).—We have received from this firm a well-printed catalogue of 80 large pages, giving descriptions and illustrations of their well-known makes of engines specially designed for electric lighting, &c. The frontispiece to the catalogue is a large engraving showing the engines and boilers put down by Messrs. Marshall at the Liverpool Exhibition of 1886-87 for the large installation of the electric light there. This installation consisted of three 20-horse, three 30-horse, two 40-horse, one 14-horse, one 10-horse, one 8-horse, and one 4-horse-power Marshall engines and boilers of various types, driving in all 10 dynamos of a total of 85 arc lamps and 1,750 incandescent lamps. Following a comprehensive price list come particulars of the numerous prize medals which have been awarded the firm, amounting to over 250, gold and silver. In the introductory matter Messrs. Marshall announce that they have made upwards of 18,000 engines at their works at Gainsborough, many of which have been specially built for electric lighting purposes. The catalogue is well arranged, and the information contained is all that can be desired. In particular, a very full description is given of a long-stroke horizontal fixed engine, fitted with Hartnell's patent automatic expansion gear. These engines are constructed of from 12 to 35 horse-power, and have been specially designed to reduce to a minimum the expense of steam-power in first outlay and in repairs and maintenance, but especially to reduce to the utmost the consumption of steam per horse-power given out. They have long strokes, large working parts and steam passages, quick piston speeds, and great indicated power; whilst, in uniformity of rotation under the most sudden variation of load, the firm claim that they are a great success. The cylinders are made of cold-blast iron, and are steam-jacketed, with a separate liner forced in. The stroke is twice or more the diameter of the piston. The pipes, ports, and passages are large. The expansion valves are on the back of the main valves. Above 11in. diameter short ports are introduced, and double valves at each end. A stop valve is fixed to the cylinder, and cylinder cocks, displacement lubricators, indicator bosses, &c., are provided. An automatic sight-feed lubricator is also applied. The crank-shaft brasses are in four pieces capable of horizontal and vertical adjustment, a very useful arrangement. The automatic regulator is very powerful and extremely sensitive. There is no throttle valve. The engine is controlled by the regulator, by means of a simple expansion gear, so perfectly that the whole load may be instantly removed with but slight variation in the speed. The cut-off extends to about five-eighths of the stroke. Full descriptions and illustrations are also given in the catalogue of several kinds of engines, boilers, saw benches, saw spindles and carriages, mortar mills, friction hoists, threshing machines, &c., made by the firm. Accompanying the book is a loose sheet giving a list of some of the principal electric light installations driven by engines and boilers made by Messrs. Marshall. The installations number about 200, and include large public buildings (such as the Bank of England, the British Museum, &c.), commercial establishments, shipbuilding yards, mansions, private residences, &c., at home and abroad, representing in all a total of nearly 4,000 horse-power.

MESSRS. W. H. WILLCOX AND CO.—This firm send us illustrated particulars of Entwistle and Kenyon's patent parallel vices, several kinds of which are, no doubt, familiar to our readers. The list includes the bench vice, portable vice, drilling, planing, and shaping machine vices. A number of very favourable testimonials are appended from users in this country and America.

MESSRS. GANZ AND CO.—We have received from Mr. Charles Flesch, Messrs. Ganz and Co.'s representative in Australasia, a pamphlet giving a lengthy description of the Company's system of electric lighting. A long list is given of central stations erected by the Company, comprising the transformer plants, up to the middle of last year ; they are 74 in number, and include several colonial stations.

Digitized by Google

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

February 20, 1890.

2,759. J. A. TIMMIS. London. Improvements in the lighting of railway trains by electricity.

February 21, 1890.

2,819. C. LÜTCKE, Jun. London. An improved electrolytic solution for galvanic batteries.

2,825. W. WHITE. London. Improvements in bases, covers, and fixings for electrical safety fuses, switches, and the like.

2,844. L. B. ATKINSON. London. Improvements in the construction of continuous-current dynamo armatures.

February 22, 1890.

2,876. H. C. WALTER. London. Improvements in safety apparatus and devices for preventing danger from high-tension electric currents.

2,905. T. HORN. London. An electric indicator for revolving speeds.

February 24, 1890.

2,945. A. M. F. LAURENT CÉLY and J. A. TIMMIS. Westminster. Improvements in and relating to and in the manufacture of electric secondary cells.

2,957. J. J. A. AUBERT. London. Improvements in electric meters.

February 25, 1890.

2,963. R. C. SAYER. Bristol. Improvements in the arrangements for and mode of working electric and other railways, in such a way that all may be introduced collectively, or singly as auxiliaries to existing railways.

2,986. W. F. WOLLIN and E. H. WERLINE. Birmingham. Improvements in electric lamp sockets and devices attached thereto for regulating the light.

2,996. R. J. F. MOSTYN. London. Improvements in electric meters.

3,024. H. H. LAKE. London. Improvements in electric motors (E. B. Parkhurst, United States).

3,028. A. C. REIGNIER. London. Improvements in dynamo-electric and electro-dynamic machines.

February 26, 1890.

3,058. J. J. BINNS. London. An improved electric and tubular pneumatic action in organs, and in means of working the combination pistons of the same.

3,071. W. J. S. BARBER-STARKEY. London. An electric meter.

3,082. RUDOLF LANGHANS. London. An improvement in filaments for incandescent electric lamps.

3,094. THE MINING AND GENERAL ELECTRIC LAMP COMPANY (LIMITED), D. G. FITZGERALD, and A. H. HOUGH. London. Improvements in portable electric lamps, more especially intended for miners' use.

3,096. S. Z. DE FERRANTI. London. Improvements in electric meters.

3,097. S. Z. DE FERRANTI. London. Improvements in electric meters.

February 27, 1890.

3,133. F. R. BOARDMAN. London. Improvements in or relating to electric lamps.

3,152. W. A. THOMS. London. Improvements in the manufacture of electrical conductors.

3,152. W. A. THOMS. London. An improved mode of manufacturing electrical conductors.

3,163. P. P. ALEXANDER. London. Improvements in electric switches.

3,169. C. E. CARPENTER. London. Improvements in electro-heating apparatus. (Date applied for under Patents Act, 1883, Sec. 103, 6th August, 1889, being date of application in the United States.)

February 28, 1890.

3,193. J. SWINBURNE. Surrey. Improvements in and connected with transformers, electrical measuring instruments, and insulation.

3,196. S. WALKER and G. MILLS. Lancashire. Electrical and steam application for actuating separate and independent alarms in connection with valves.

3,231. J. SHIPP. London. Automatically regulating and keeping constant the electromotive force or pressure of any electric circuit.

March 1, 1890.

3,272. G. E. FLETCHER. Stockport. Improvements in switches for controlling electric circuits, especially electric light circuits.

3,273. G. E. FLETCHER. Stockport. Improvements in the lighting of railway trains.

3,304. M. C. GREENHILL. London. Improvements in apparatus for enabling a supply of gas or other fluid, or a current of electricity to be obtained for a limited time on prepayment therefor.

March 3, 1890.

3,322. T. KEEP. Birmingham. An improved voltaic battery (T. and S. Morrin, Limited, New Zealand).

3,329. J. CLEGG. London. Improvements in the manufacture of light emitters or illuminants for electric or other lamps.

3,335. A. SCHIRNER. London. An improvement in holders for incandescent electric lamps.

March 4, 1890.

3,419. C. J. VAN DEPOELE. London. Method of and apparatus for producing and utilising pulsating electric currents in closed circuits.

3,472. J. W. LITTLE. London. Improvements in apparatus or appliances for operating electrically devices for informing passengers in railway carriages as to the names of stations on the line, or for conveying to them other information.

3,484. E. SCHWEIZER. London. Improved electrical secondary clockwork.

March 5, 1890.

3,509. C. A. SAHLSTRÖM. London. A portable hot-air, steam and electrical bath, with arrangement for inhaling and otherwise employing vapours, plain or medicated.

3,534. L. W. DE GRAVE. London. A new or improved device for extending the circuit of incandescent lamps.

3,544. F. J. PATTEN. London. Improvements in and relating to electric telegraphy.

March 6, 1890.

3,572. Sir C. S. FORBES, Bart. Improvements in primary batteries.

3,574. H. R. LOW and G. E. B. PRITCHETT. London. Distributing electricity.

March 7, 1890.

3,622. J. CLEGG. London. Improvements in the manufacture of light-emitters and illuminants for electric lamps.

3,654. H. EDMUNDS. London. Improvements in apparatus or means for supplying, distributing, controlling, and metering electric currents.

3,658. J. STEINHEUER. London. Improved electrical signal clock.

3,660. S. B. MCCLELLAN. London. Improvements in apparatus for connecting and disconnecting electric circuits.

3,663. H. EDMUNDS. London. Improvements in means or apparatus for metering electric currents, applicable also for indicating or recording the electrical condition or charge of secondary batteries and the like.

March 8, 1890.

3,697. J. ANDERSON. Glasgow. Improvements in galvanic cells and batteries.

3,717. L. WEIGERT. London. An improved electrolytic solution for galvanic batteries.

3,731. THE MINING AND GENERAL ELECTRIC LAMP COMPANY (LIMITED), and D. G. FITZGERALD. London. Improvements in or connected with the positive elements (negative electrodes in charging) of secondary batteries, which elements are applicable also as cathodes in electrolysis.

3,732. J. HOPKINSON. London. Improvements in electro-locomotives.

March 10, 1890.

3,787. H. W. LIBBY. London. Improvements in electric railways.

March 11, 1890.

3,804. Sir WM. THOMSON. Glasgow. Improvements in rheostats.

3,805. W. BRIERLEY. Halifax. Improvements in electrical terminals. (Heinrich Arld, Germany).

3,840. S. C. C. CURRIE. London. Regulation of alternating generators.

3,841. SIEMENS BROS. AND CO. (LIMITED). London. Automatic apparatus for compensating variation of current in electric conductors (Alfred Mills Taylor, India).

3,842. SIEMENS BROS. AND CO. (LIMITED). London. A circuit breaker for secondary currents from electrical transformers (Alfred Mills Taylor, India).

3,861. B. DEATH. London. An improved holder for incandescent lamps.

March 12, 1890.

3,900. L. PYKE and H. T. BARNETT. London. Improvements in insulation and cooling of electrical inductoria.

3,913. G. KAPP, W. C. JOHNSON, and S. E. PHILLIPS. London. Improvements in alternate current transformers.

3,924. H. H. LAKE. London. Improvements in electric batteries (The Crosby Electric Company, United States).

March 13, 1890.

3,937. W. S. RAWSON and C. S. SNELL. London. Improvements in electric flash signalling lanterns and apparatus in connection therewith.

3,947. J. CLEGG. London. Improvements in the manufacture of light emitters or illuminants for electric or other lamps.

3,960. J. WOOD. London. An improved galvanic medical appliance for use and wear upon the human body.

3,963. W. SCOTT. Glasgow. Improvements in or relating to electrical switches.

3,969. SIEMENS BROS. AND CO. (LIMITED). London. Improvements in switch boards for stations of electrical supply (Alfred Mills Taylor, India).

3,984. A. DUVAL and H. NELSON. London. Improvements in or connected with shades, globes, or glasses for electric or other lights.

Digitized by Google

SPECIFICATIONS PUBLISHED.

1890.

8,958. FRAGER. Electric meter. (Price 11d.)
12,773. WHEELER. Electric railways. (Price 8d.)
16,816. HARNESS. Electro-medical apparatus. (Price 8d.)
17,611. HARNESS. Electro-medical apparatus. (Price 6d.)
18,018. BOULT (RIES and another). Electro-magnetic brakes. (Price 8d.)
18,638. DICKINSON. Driving electrical vehicles. (Price 6d.)
18,838. PITT (Johnstone). Electric conductor conduits. (Price 11d.)
20,235. CORRENS. Electric accumulators. (Price 6d.)
20,260. STITZEL and others. Electric semaphores. (Price 8d.)
20,261. STITZEL and others. Railway electric semaphores. (Price 8d.)
20,288. TATHAM and TATHAM. Conduits for electric conductors. (Price 8d.)
20,717. PRENTISS. Electric contact mechanism. (Price 6d.)
20,734. HADDAN (Gillette). Magneto-electric machines. (Price 8d.)

COMPANIES' MEETINGS & REPORTS.

London Electric Supply Corporation (Limited).

The third ordinary general meeting of the shareholders of this Corporation was held at the Cannon-street Hotel on the 31st ult., under the presidency of Mr. J. S. Forbes.

The MANAGER and SECRETARY (Mr. Charles Waller) read the notice calling the meeting, and the report of the Directors was taken as read.

The CHAIRMAN said that the Earl of Crawford, who until very recently presided over the Corporation, had, for reasons of health chiefly, found it incumbent on himself to vacate the chair. His (the speaker's) colleagues had been flattering enough to him to suggest, as the Corporation was about to enter on a new stage—that was to say, as the works were approaching completion, and the Corporation was likely to develope at no distant time into a working undertaking,—that he might be of some service to them by taking his lordship's post. He thought that that was an occasion for adverting to the great services which the Earl of Crawford had given, not only to the Corporation but to electrical science generally, having been a pioneer of science. His lordship had worked incessantly—and, as far as he (the speaker) knew, with no other reward than unremitting labour, great responsibility, and, at present, no profit—in the development of the electric lighting science, and the shareholders' interest particularly. He was sure they must all regret the reason why his lordship had felt it incumbent on him to take a period of repose. He would address them as briefly as possible, and yet somewhat exhaustively with regard to the figures, because this concern, like all others when it passed out of abstract proposition into the region of fact, turned greatly on the figures. The accounts were submitted upon the model required to be made by the Board of Trade, and he thought they rested upon this possibility: that, in accordance with the conditions upon which this and similar companies had come into existence, there might be a time when some other interest—local authority or otherwise—might acquire the right of taking this enterprise over upon certain terms set forth in the Concession Charter, or Provisional Order, as it was called. It therefore became a matter of public interest that the accounts should be stated and carried on from year to year in a fashion that would afford an opportunity in case of need, of the terms and conditions as regarded expenditure and so forth upon which their enterprises might be taken over. With regard to their share capital, the Corporation were authorised by their articles of association to raise £1,000,000, divided into 200.000 shares, and under these powers 111,000 shares had been issued and paid for, representing £555.000, which had gone into the coffers of the Company. For their future requirements there remained to be issued 89,000 shares, representing £445,000, but there was no immediate probability of this part of the capital being increased. Comparatively recently, too, the shareholders authorised the creation of 50,000 Preference shares of £5 each, or £250,000. This was to get rid of the incubus of a debenture debt. Every one who was associated with these enterprises knew the great advantages of depending rather on subscribed capital than borrowed capital, because, where the future was somewhat speculative, from the nature of the enterprise—somewhat uncertain—it was putting too many eggs in one basket to trust to having such a return, or such capital in their possession at a particular moment as might be required to pay off a debt falling due at a particular date. Their debentures had therefore been cancelled, and they were covered by a security equally efficient for the raising of money and safer to the shareholders. The Preference shares had all been issued by the authority of the proprietors, and up to the date of the report £2 per share had been called up, leaving them an unexhausted £150,000 available for the future of the undertaking. The only point they had to consider was whether, with the cash in hand and with the reserve of cash subscribed—that was to say, the balance of the Preference shares and the reserve of force behind in the character of the 89,000 shares—there was such a reserve as was a good foundation for resting upon, and that the extension of the Company from time to time was provided for. They would be able to judge of that when he came to deal further with the distribution of the capital in the next account, No. 2. That was made up in great detail. There seemed to be no fewer than 15 items analysed for the purpose of that account, and generally in its form it was an account prescribed by the Board of Trade for the purpose of showing, as he had said before, from year to year the various items of cost, and establishing the Company and carrying it on. Upon the founding of the business, up to December 31, 1888, the Company had expended £378,830, but that amount for the purpose of carrying forward had been diminished by a sum of £5,127, which was the value of certain material sold and certain depreciations written down. Therefore they started the year 1889 with an expenditure of £373,703, and during the past year they had been spending the shareholders' money in pretty considerable amount and somewhat rapidly, no less than £131,555 having been disbursed within the year. Of course, assuming it was capital which was to have sooner or later a return on it and was sooner or later to achieve an object and establish a going concern as a remunerative business, the more rapidly it was spent the better. The result of these two items put together showed that they had expended up to the 31st December, 1889, £505,258. They had reserved on capital account £649,750, of which there was unexpended at the close of the year £144,491. That was unexpended capital already paid in, and to what portion of it was liquid they had to add £150,000, unpaid on the Preference capital, to estimate the amount of money in the possession of the Company and assured to them in order to complete and develope the undertaking. Beyond that, assuming that they decided upon going in for further orders and concessions, they had the reserve he had mentioned of ordinary capital. It was obvious that, having that large amount of capital at command, there would be no necessity to talk of ordinary capital, as the reserve would be more or less available for the future as the results of the undertaking were more or less successful. As far as the Directors were able to bottom a business of this sort, which had in it some elements of speculation and uncertainty, they had every reason, upon the advice of their engineer and their managers, and acting upon their own judgment, and from the information before them, to believe that the resources on hand were fully sufficient to carry out the undertaking as far as their existing powers were concerned. Going from that, one was obliged to refer to the next account, No. 3, which, after all, was the crux of the whole business. It was astonishing how easily people forgot the conditions of an undertaking in which they embarked. That was an enterprise which had involved a great many speculative quantities, and something also risky—the finding out how practically to develop and give form to the ingenuity or the genius of the inventor. He was one of the few men, he was afraid, left living who had to form the railway system, and he remembered commencing business as a lad when there was no organisation whatever. Everything had to be made. Someone had conceived a railway, but how it was to be done, and when done how it was to be broken as a commercial undertaking, involving daily duties of the most complex and difficult kind, no man had conceived. He went through it all, and therefore, going back to a parallel, this class of undertaking was exactly what the railway system was when the great genius of Stephenson conceived it possible and set to work to do it, and, having constructed it, it had to be made what the railway system was now. This was not done in a day or without many errors, and it was not done without a great deal of risk and a great deal of loss, which every one would have avoided if he had been as skilled then as people had become since. In relation to a thing so subtle and so beyond human knowledge, as electricity was, they had much to find out; and they must not suppose that in this enterprise, any more than in any other, the thing was going to be brought to perfection without a great many mistakes and a great many things to find out. Now, with reference to the revenue account, it meant how far those scientific ideas had been concreted and turned into a commercial concern. Everyone knew that at the outset of an enterprise such as theirs great relative cost had to be incurred in producing a comparatively small result. As in the case of a man opening a shop, they had to go to great expense, and then they had to wait for customers, and customers might come more or less slowly; but obviously, whether they came slow or fast, certain charges, rent and taxes, the machinery, the power whatever it was to keep the thing going, must be paid for. That was the position of the Company; and anyone who supposed that in the first year or two in an enterprise like theirs, in a transition state, and quite uncompleted or incomplete as regarded its entire development, was going to be a very brilliant undertaking in the way of a return on its capital, must have been, he was afraid, without that amount of experience or reflection which ought to guide men of business in matters of this sort. He was sensible that these accounts contained a great many items of expenditure which were very large in proportion to the result achieved. On the other hand, he was equally sensible of the fact that they did compass and cover a great deal more that equally well might have been achieved during the period if the development of the Company, and of such a new, complex, and very difficult business, had been further advanced. The amount expended on revenue account had been £27,638, less a small balance of profit of £1.249. This expenditure would, however, have enabled them to sell a great deal more current at 7¼d. per Board of Trade unit, and a great deal more current under contracts, and to have obtained a great deal more rentals from meters, converters, &c., than they had done if their business had been longer established. It was obvious that the thing must go very slowly until the machinery for generation and distribution was made perfect. They might say Why had it not been? Well, it was very difficult. He hardly knew any enterprise in which Parliament had had a voice which had been so hampered and obstructed as electric lighting. Some of them knew, probably, that the first legislation on the subject was conducted by one of the most able men in the Kingdom, a man who put his heart into it with the view of doing what he thought was strictly just between the inventor, the promoter, and the public—Mr. Chamberlain. He obtained advice from a great many people; but he got alarmed at the representations which were made to him respecting the hardships inflicted on the public by the gas and water companies and it ended in his insisting on conditions in the Electric Lighting Act which made electric lighting impossible, and delayed its introduction into this country for a great many years. After a time people began to ask why they had no electric lighting in England; and it was seen that the

Digitized by Google

reason for this was simply because no one but an idiot would invest his money in an enterprise hampered by such conditions. He himself, though not at the time immediately connected with any electrical company, gave a great deal of evidence before an important Parliamentary Committee; and he pointed out, in language tolerably obvious, he thought, that it was insane to suppose that anyone was going to put his money to any extent into an enterprise resting upon such conditions. The result of that Committee was that the legislation was altered two years ago, and the worst of the conditions were considerably modified, so much so that it became possible to get on with the electric lighting enterprise. They did not, however, get rid of all the conditions under which these companies, and their own Company in particular, had to work. Financially, they were not bad conditions. They entitled them to receive all the profit they could make out of their business without interference, and they gave them the sufficiently long term, 42 years, to make the investment of the capital and its redemption tolerably secure. But still immense anxiety was shown by Parliament to protect the public interests. Not only had they got what were called Provisional Orders, with a great number of conditions, some of them almost incomprehensible, and all more or less conflicting with each other; but, in order to put this state of things right, the Board of Trade, to which, under modern legislation, the conduct of everything seemed to be gravitating—the railway interest, the shipping interest, the electric light interest—were to previse and legislate and to do what the companies themselves had much greater opportunities of doing—to previse and legislate with this great advantage, of having at their backs a vast amount more skill than the Board of Trade could possibly have, and with nothing else to do. Still the Board of Trade must regulate; and to people who were impatient and wanted to know why they did not get on, he would say that they could not move under the present legislation without having to consult a great number of authorities, because their getting on depended on their interference with the public rights and the public streets; and they had to refer to the Board of Trade, the County Council, the local authorities in every parish, the Postmaster-General, the gas companies, the water companies, the telephone companies, and so on, and they could not move until they had satisfied every one of these conflicting authorities. Let them take the Postmaster-General: that official was in possession of the streets. To a certain extent he was a competitor for the occupation of the streets, and they could do nothing without him. Not only must they not interfere with anything which the head of the Post Office had done already, but they must not interfere with anything he might do in the future. This was not a very easy task to perform, and when they had settled with the Post Office they had to go to the local authority, then to the County Council, who were already so much occupied in regulating everything and everyone that they were not always in harmony with either the Postmaster-General, the Board of Trade, or the local authority. They had to steer their way clear and through all these obligations, and they therefore would have to ask the shareholders to be a little patient and forbearing, as he was sure they would be. Of course those difficulties would be overcome with patience and a knowledge of the business. With the expenditure they had incurred on revenue account they could have produced a great deal more current for sale and realised a great deal more money if they had had their mains and appliances for the conveyance of supply more advanced. He knew he was about to enter upon delicate ground and to get into the region of prophecy; but he was bold enough to have the courage of his opinions, though he knew what an astute or probably hostile critic might say next year if he found that, with the larger development of the business, there was no better proportionate result than £1,249 of profit out of £27,638 received. He for one believed that there would be, and that the amount would go on increasing at a very rapid rate when they got over the preliminary difficulties to which he had called attention. He observed that the sum of £1,249 was all the money which they had really got out of the working of the concern, excepting the interest on the deposit account and sundry discounts amounting to £1,003. These two items together would have been the whole fund out of which any question of dividend could have arisen in dealing with those accounts, but for a kind of godsend—that was, the profit on the sale of overhead wires, &c, £3,173. That item arose out of the re-arrangement of the powers of these companies. There were several conflicting companies, but the most important for their purpose was the Metropolitan Company, which was presided over by Sir John Pender and heavily backed. They had got large concessions; in fact, the two companies, the Metropolitan and London together, had got what might be called the lion's share of London. The Metropolitan Company got concurrent powers in certain places with the London Company, and they had to work alongside them. At other places they were turned out, and the Metropolitan Company got exclusive powers, notably in Marylebone and the Strand; but the London Company were already on sufferance there until their Provisional Orders were passed. They had to turn out of Marylebone and the Strand because Parliament had given these districts to someone else; but there were the wires, &c., and the Metropolitan Company, like sensible people, said they had better take these things over. The London Company therefore made a bargain with them which was a great advantage to the Metropolitan Company, to get into immediate possession, and it was a certain advantage to the London Company not to have to pull their wires down and walk out; and the Metropolitan Company paid them a certain price. There were two items there, one distinctly revenue and the other capital. They had taken the capital and written it off; the balance, the part belonging to revenue, had gone to the credit of profit and loss for the year; and it afforded a balance out of which to meet the obligations of the debtor side of the account, and it enabled the Company to pay a dividend on that portion of the Preference capital which had been subscribed up to December 31st, leaving £920 to be carried forward for the benefit of the next profit and loss account. After referring to the reserve fund account and to certain items in the general balance-sheet, he passed on to the Directors' report, and said that they had thought it very important that at the present stage of the business, when a great idea—involving, he was bound to say, a good deal of the unknown, and, therefore, a good deal of possible risk, as well as of sound and immense advantages—had been sufficiently developed and in practice to enable the genius underlying it to speak, as it were, and show the point which it had got to. Upon the Board rested great responsibility and constant labour. They had thought that the shareholders themselves should have had Mr. Ferranti's report appended to the Directors' report, so that the shareholders might discuss it amongst themselves. Mr. Ferranti had told them his own story, and the Directors were so far responsible for it that they published it, and made it part, as it were, of their own report. It was much the more important part of the report, as it dealt in actual figures and facts. This was why they had given it the prominence of the first paragraph in their report, and he commended to their careful consideration what Mr. Ferranti had stated. In the next paragraph the Directors said that they had carefully considered the means of turning to better advantage the plant at the Grosvenor Gallery station. Their enterprise began there. It might, in fact, be described as the pioneer of electric lighting, certainly in London, and, like Topsy, it grew. It was not intended originally for a centre of supply for a great city, and very soon the demand outgrew the possibilities of the position. It was an essential element at present in the conduct of this business, but as soon as they were in full work at Deptford, the position of the Company, and the exigencies of the position in Bond-street, would require that the Grosvenor Gallery should cease as a centre for generating the current, though it would not cease to be a centre of supply. They had decided to remove the machinery to Deptford. Then they said in their report that the applications for current now in hand were growing from day to day. That was quite true; they could not meet the demands of the public upon them at present, and there was nothing like realising the inevitable. People must make up their minds that, until there was a great deal more known about the electric light than there was at present, they must be subjected from time to time to serious inconvenience. He was old enough to remember when gas came in, and when one of the great difficulties which gas companies had was to induce the people to turn out the gas instead of blowing it out, which they had been accustomed to do previously with their candles. People were slow to learn; but in course of time they would learn, as they had in the case of gas, to deal properly with the electric light. Their boundaries and those of the Metropolitan Company were being delimited, and they were now very good friends with that Company, both of them realising that they had a great deal to do and a very fine field for scientific pursuit. With regard to the Preference capital, the Directors had not made further calls, which they might have done, as they thought it more advantageous in the interests of the Preference shareholders themselves, in view of the recent state of the Money Market, that they should only be asked to pay up the unpaid capital as it was required. Moreover, the dividend on the Preference capital was not cumulative, and they had only to pay interest on the portion that was paid up annually. In order, however, to keep faith with the Preference shareholders, and also to keep within the terms of the prospectus, the Preference shareholders had the option, if they desired to exercise it, of paying up the balance due on their shares whenever they pleased between now and July next. He had already referred to the resignation of the Chairmanship of the Company by the Earl of Crawford, and the appointment of himself by his colleagues to that position. He had required some persuasion to believe that he could be of any service to the Board, but they had thought so, and, *noblesse oblige*, he had assumed the duties. He hoped he would be worthy of the confidence of his colleagues and of the proprietors. He desired to impress upon the proprietors the obligation that they owed to the eminent firm of accountants, Messrs. Kemp Ford, and Co., who acted as auditors to the Corporation. They had given great diligence and care in assisting the Board to put the accounts on a thoroughly sound basis. He had now concluded the remarks which he wished to address to them on that occasion. He would not read Mr. Ferranti's report, but he trusted that the shareholders would do so themselves—read, mark, and inwardly digest it. It contained a great deal of interesting information, and the concluding paragraph contained the philosophy upon which they had embarked their money it said:—"It may be well here to remind the shareholders that in erecting its works at Deptford on a site immediately adjacent to the Thames, and upon a sufficiently comprehensive scale, the Corporation has taken its lesson from the gas companies. These companies commenced with small stations in the centre of populous districts; but experience has since shown that this was an undesirable method of proceeding, and that the true way to secure both economy and efficiency is to generate gas on a large scale on a commodious site at the water's edge, and at some distance from the district to be supplied. The Corporation has followed this eminently practical conclusion, and when the Deptford works are further advanced, the wisdom of following an example proved to be so successful in an enterprise of a kindred nature will be apparent." Of course, what was referred to in that paragraph in connection with gas companies was the Becton Works. Everyone knew that the largest gas corporation in London had done exactly what was stated in the paragraph which he had read. First of all, there were a number of detached works all over London, and they had been gradually concentrated at Becton. As to the arguments about a waterside site, they had gone to Deptford with a clear prevision. Coal would be a chief element of expenditure, and they had proved that they could get it delivered there cheaper than at the Grosvenor Gallery. There was one other remark he wished to make. Mr. Ferranti, and the Board of Directors leaning upon him, had embarked on a method different from other known methods—the high-tension system. If Mr. Ferranti had not done this, the London Company would have been in the same "swim" as the other Companies who had taken to the low tension, and they would have all the benefit of the advantages, or, on the other hand,

Digitized by Google

the disadvantages, of that system. If Mr. Ferranti's system were right, the London Company would be in advance of all the other Companies. The experiment was now being tested by practice, and, like all experiments, was not achieved in a single day. But a great many difficulties had been overcome, and a great many things said to be impossible had turned out to be possible. He had had the opportunity of going to Deptford with two very eminent Americans, one of them the great father of this industry, Mr. Edison. That gentleman said that at all events it was a bold and great experiment, and they had nothing like it in America; and he was good enough to express a hope that it might prove a success, in which case it would be a gigantic triumph. Mr. Edison's lieutenant, a man trained by Mr. Edison himself, who had had a great deal to do with the electric telephone, also the other day visited the Deptford works, and was quite as much charmed as Mr. Edison; but he went a little further, and said that what they were doing at Deptford was the right thing—concentration in one place. He added that the great mistake that had been made in America, and particularly in New York, had been in having too many places, and that in that city they were endeavouring to see how they could reduce the number of generating stations by putting three and two into one. He confessed that he had felt a little comfort in those remarks, because the the contention of some was that at Deptford the Company was putting too many eggs into one basket. He concluded by moving the adoption of the report and accounts.

LORD WANTAGE seconded the motion.

In the discussion which followed, Mr. BENJAMIN KISCH, Mr. SCOTT RUSSELL, and LORD KINGSBURGH (Lord-Justice Clerk), took part. The latter stated that he had been reading in an old Blue Book some evidence given by Sir Humphry Davy on the subject of the gas supply. As the Chairman had said, the idea at that time was to have a number of isolated stations, and Sir Humphry stated that it would be absolutely improper, from a scientific point of view, to have any gasometer that would hold more than 20,000 cubic feet, that each gasometer must be built into a stone tower, and that these stone towers must be at least 40ft. apart. Sir Humphry was asked whether he was aware that at the time, in Paris, a gasometer was being constructed to hold 200,000 cubic feet; and he replied that whatever "our more rash French neighbours" might do, he could only repeat, as a scientific man, that no gasometer ought to be built to hold more than 20,000 cubic feet. He could not help thinking about this when, on coming into town on the Midland line, he saw certain gasometers holding seven or eight times as much as the single gasometer which was being built in Paris at the time that Sir Humphry Davy was giving his evidence, and all so close together that one could hardly pass between them. He thought that this incident bore on the point dealt with by the Chairman as to the construction of the works of the Company at Deptford. Another incident which he desired to mention had reference to what the Chairman had said with regard to high-tension current, as to which some persons appeared to be very much alarmed. In an old number of the *Quarterly Review* he came across an article on railways, and after the reviewer had spent about 14 or 15 pages in highly praising railways and saying that they would be of enormous use, he observed, "But what shall be said of the madness of men who propose to run these trains on these iron roads at a speed of 20 or even 25 miles an hour!" And then he expressed a hope that Parliament would act firmly in the matter, and absolutely restrict them to 14, or, at the utmost, 16 miles an hour! He (Lord Kingsburgh) thought they might say that, while restricted by the Board of Trade and some other interests, they had developed a little since then; and that, so far as regarded their Company, they would be able to show that the wisest plan was to have one large central station, and that they need not be afraid, if they took care to have the proper strength, to communicate the current to all parts of London.

The CHAIRMAN, in responding, said that the statement in the engineer's report concerning the mains purchased and laid was a very frank one. These mains were not designed by Mr. Ferranti, but in concert with Mr. Ferranti, and they were carried out by a great manufacturing firm. They were, according to the lights possessed by this particular firm, calculated to do a certain thing. They were to be tested up to 10,000 volts, and they were tested up to that, and beyond, he believed. Among other things they had to find out was that there was a great difference between tests in the laboratory and after the thing was put in the earth. 10,000 volts was in excess of anything they had to stand, and if they had been able to stand half of 10,000, they would have been considered to perfectly answer the purposes for which they were conceived and laid. Unfortunately, however, they did not. He would not at that moment go further into this matter, as it was possible that they might have to resort to law to recover damages for unworkable construction or want of skill. With reference to the question of permanent mains, plenty of mains had been laid for low tension, but for high tension Mr. Ferranti, among other things, had invented his own main—what was called the permanent main; and that main had been manufactured and tested, as far as a test could be applied on a limited length of it, on the Company's own premises up to 20,000 volts; and what Mr. Ferranti predicted was this—that whatever the reason of the defect might have been in the particular main constructed and laid, which had failed, these permanent mains were so different in the principles of construction that they would not fail. Whether they would or would not he (the speaker) did not know, nor would any one present be able to say until one process was gone through—that of putting them in the earth, covering them up, connecting them with the supply in houses, and turning the current on. Then if they had any weak places they would be revealed, just as the weak places were revealed in the mains which had failed. It was no good going on with the present mains up to anything like the tension that was necessary, and they had been obliged to cut their coat according to their cloth. Instead of sending 5,000 volts through them they had only sent through 2,500; even at that low tension they had served an exceedingly useful purpose to the Company as a sort of stop-gap, because, but for these mains, they could not have conducted their business in London even as they had done. They had thus settled the point that they could send current from Deptford to the Grosvenor Gallery in an instant of time, and in considerable quantity. He thought that the remarks of the Lord-Justice Clerk should be regarded by them as very consolatory.

The motion was unanimously adopted.

Resolutions were afterwards proposed declaring the dividend recommended on the Preference shares, re-electing the retiring Directors—the Earl of Crawford, Sir Coutts Lindsay, and Lord Wantage—and re-appointing the auditors, Messrs. Kemp, Ford, and Co.

A vote of thanks to the Chairman and Directors brought the proceedings to a close.

The following is Mr. S. Z. de Ferranti's report, referred to by the Chairman:—

"GENTLEMEN: I have the honour to report that during the past year the general works and buildings at your Deptford Station have been completed, and a large amount of machinery for supplying electric current has been erected. There is now in complete working order a plant consisting *of two* 30,000-*light dynamos*, with engines, boilers, and other accessories to correspond.

"In order to utilise this supply of current in London, mains were purchased and laid in the early part of last year, but I regret to say that some of them have proved a very great failure, owing to which you are not in a position to utilise more than one-quarter of the capacity of your Deptford plant. Had these mains succeeded you would now have been in a position to utilise the whole of the Deptford machinery above mentioned for the supply of the Corporation's customers in town.

"The Grosvenor central lighting station has continued to supply current to a large number of consumers during the past year, notwithstanding the

PATENT
SILICIUM BRONZE AND SILICIUM COPPER WIRE.
The best for overhead Telephone and Telegraph Lines,
AND ALL ELECTRICAL PURPOSES.
Hard Drawn High Conductivity Copper Wire.
ROLLED AND DRAWN
PHOSPHOR BRONZE.
PHOSPHOR BRONZE
BEARINGS, BUSHES,
AND OTHER PARTS OF
ELECTRICAL MACHINERY.
SOLE PROPRIETORS of the British, Indian and Colonial Patents,
THE PHOSPHOR BRONZE COMPANY (Limited),
87, Sumner Street, Southwark, London, S.E.
WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

Digitized by Google

great difficulties attending its position in a most populous and busy district, where space and every other convenience are much limited. In order to use the plant of this station to its full advantage, and to secure the benefits of the riverside site, arrangements are now being made for its removal to Deptford, where, before the autumn, it will be in a position to contribute to the supply of light in London in a more economical and efficient manner than now. You will then possess plant capable of generating power for 90,000 lights, with which, after making most liberal allowances for reserve, you will be able to supply 60,000 lights simultaneously.

"In addition to the above, two large dynamos of the capacity of 200,000 lights each are being built. These machines will at first be used for 100,000 lights each, and the engines and boilers for this output are now completed, and the machines themselves are in a fairly advanced state, the heaviest and most difficult parts of them being well in hand. *It is expected that these machines will be completed about the end of the present year*, when the productive capacity of your plant will be raised to 290,000 lights, and allowing for reserve in accordance with the requirements of the Board of Trade, you will be able to supply some 160,000 lights simultaneously. At a later stage the current for 200,000 additional lights will be obtained from these machines by simply adding the necessary engine-power.

"The laying of distributing mains has been commenced and fair progress made in a portion of the Corporation's area. The manufacture of permanent trunk mains by the Corporation's own staff has been vigorously pushed forward, but partly on account of the time occupied in getting a new system into working order, and partly owing to the great difficulties experienced in meeting the varying requirements of the several local and other authorities, none have yet been laid. These mains have been tested on the Corporation's own premises, and the results show that they are capable of withstanding greatly more electrical pressure than will be required in ordinary working, and also that they are in every sense a practical and commercial success. The defective mains now in use between Deptford and London will shortly be replaced by these permanent trunk mains, when a supply of current to the full capacity of the machinery now erected at Deptford may be utilised.

"During the past year great difficulty has been experienced in obtaining a satisfactory meter for the registration of current supplied to customers, and this difficulty has entailed a certain amount of loss to the Corporation. Recently, however, several meters of a satisfactory type have been put into use, and now more than half the Corporation's customers are supplied through these meters. It is believed that before very long the Corporation will be able to supply all their customers by meter.

"It may be well here to remind the shareholders that in erecting its works at Deptford on a site immediately adjacent to the Thames, and upon a sufficiently comprehensive scale, the Corporation has taken its lesson from the gas companies. These companies commenced with small stations in the centre of populous districts, but experience has since shown that this was an undesirable method of proceeding, and that the true way to secure both economy and efficiency is to generate gas on a large scale on a commodious site at the water's edge, and at some distance from the district to be supplied. The Corporation has followed this eminently practical conclusion, and when the Deptford works are further advanced, the wisdom of following an example proved to be so successful in an enterprise of a kindred nature will be apparent."

Exeter Electric Light Company (Limited).

An extraordinary meeting of the shareholders of the Exeter Electric Light Company was held on Tuesday at the works in New York-road for the purpose of altering a resolution come to at the last meeting, fixing the number of Directors of the Company at seven.

Mr. W. H. ELLIS, Chairman of the Company, presided, and moved the resolution, which affirmed the desirability of raising the number of directors to 10.

Dr. WOODGATES, in seconding, referred to the progress which had been made in Exeter and elsewhere in the matter of electric lighting, and said that in every place in which it had been applied in Exeter it had given unqualified satisfaction, and it was shortly to be introduced into the Albert Memorial Museum. He also spoke of the great opposition which had been raised to it by interested parties, and trusted that the public would recognise its advantages, both from a sanitary and lighting point of view. About thirty years ago he remembered seeing the first introduction of the gas stick for lighting lamps, and it was not until last year that Exeter superseded the old ladders by its adoption, so that the city was thirty years behind the times in this direction. He did not think the citizens would care to be thirty years behind the times in the case of the electric light.

The resolution was carried unanimously, and Dr. Woodgates and Mr. J. Dalke were added to the list of Directors.

CITY NOTES, &c.

ANGLO-AMERICAN TELEGRAPH COMPANY.—At a meeting of the Board of Directors of the Anglo-American Telegraph Company (Limited), held on Friday last, it was resolved to declare an interim dividend for the quarter ending March 31, 1890, of 12s. 6d. per cent. on the Ordinary Stock, and 25s. per cent. on the Preferred Stock, less income tax, payable on May 1st to the stockholders registered on the books of the Company on April 1, 1890

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The receipts of this Company for the week ended March 28th amounted to £4,558.

COMMERCIAL CABLE COMPANY.—This Company notify that they will pay a quarterly dividend of 1½ per cent. upon the outstanding stock on the 10th inst. to all stockholders of record on April 1st.

CUBA SUBMARINE TELEGRAPH COMPANY.—The estimated traffic receipts of this Company for the month of March were £4,000, as compared with £4,540 in the corresponding month of last year. The receipts for the month of December, estimated at £3,000, realised £2,995.

DIRECT UNITED STATES CABLE COMPANY.—The Board of this Company have resolved upon the payment of an interim dividend of 3s. 6d. per share, free of income tax, being at the rate of 3½ per cent. per annum for the quarter ending March 31, 1890, such dividend to be payable on and after April 24th next.

EASTERN TELEGRAPH COMPANY.—The traffic receipts of this Company for the month of March, 1890, amounted to £58,471, and to £55,987 in the corresponding period of 1889.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY (LIMITED).—Particulars will be found in our advertisement columns of the drawing of 305 Five per Cent. Australian Government Subsidy Debentures of £100 each. These Debentures will be paid off at par on July 1st next, at Messrs. Barclay, Bevan and Co.'s, 54, Lombard-street, E.C., after which date interest on them will cease.

GANZ AND CO.—A dividend of 70 florins per share has just been paid by this firm.

ORIENTAL TELEPHONE COMPANY (LIMITED).—The Directors of this Company yesterday resolved, subject to final audit of the accounts, to recommend to the shareholders a dividend of 3 per cent., free of income tax on the paid-up capital of the Company, other than the vendors' shares, for the year ended December 31st last, to place £2,000 to reserve, and write off £850 for depreciation, &c., the balance to be carried forward will be about £1,200.

SUBMARINE CABLES TRUST.—The Submarine Cables Trust announce that the coupon due in October last will be paid in full, on and after April 15th, by Messrs. Glyn, Mills and Co., of Lombard-street, E.C. The coupons should be left with the bankers for examination four clear days before payment. Certificate-holders have to present the coupons for October, 1889, only, and not those payable on April 15th next.

TELEPHONE COMPANY OF AUSTRIA.—This Company intimates that the usual half-yearly dividend to the 31st March on the Preference Shares at the rate of 6 per cent. per annum, payable, less income tax, early in April, has been declared by the Board.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended March 28th, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,515.

WEST COAST OF AMERICA TELEGRAPH COMPANY.—The traffic receipts of this Company for the month ended March 31st were £4,400.

WESTERN UNION TELEGRAPH COMPANY.—Mr. William Waldorf Astor has been elected to fill the vacancy in the directorate of this Company left vacant by the death of his father.

THE NON-CONDUCTOR OF ELECTRICITY.

WAREHOUSE.

VULCANISED FIBRE,

PATENTED.

This new material is supplied in two qualities, Flexible and Hard.

The FLEXIBLE is a substitute for Leather, Rubber, Gutta Percha, &c., and is extensively used by Brass Founders, Axle Makers, Hydraulic, Sanitary, and other Engineers, Pump Makers, Carriage Builders, &c.

It makes the best Hot and Cold Water Packings, and for Axle Washers of all kinds it is unequalled.

The HARD is a substitute for Metals, Hard Wood, Ivory, Vulcanite, Ebonite, &c., and is a good Insulator.

Sold in sheets, 5ft. 6in. by 3ft. 6in., varying in thickness from 1-50in. to 1in.

FACTORY.

FLEXIBLE, 2/- per lb.; HARD, 2/3 per lb.

MOSSES & MITCHELL, 70 Chiswell-st., London, E.C.

Digitized by Google

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Wednesday, March 26.	Price Tuesday, April 1.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending April 1, 1890. Highest.	Lowest.
£			**TELEGRAPHS.**			£ s. d.			
1,770,360	Stock	15/0	Anglo-American	49 50	49 50	5 10 0	Jan., Apr., July, Oct.	...	...
2,614,320	Stock	30/0	Do. Preferred	83 84	83½ 84½	6 10 2	,, ,,	84½	83½
2,614,320	Stock	...	Do. Deferred	14¼ 14⅝	14¼ 14⅝	...	February	14⅝	14⅜
130,000	£10	3/0	Brazilian Submarine	12½ 13	12¼ 12⅝	5 17 8	Mar., June, Oct., Dec.	12½	12⅜
112,900	£100	5%	Do. 5 per Cent. Bonds	100 102	100 102	4 18 0	January and July	...	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	104 107	104 107	4 13 6	June and December.	...	..
16,000	10	9/0	Cuba Submarine	11 11½	11 11½	7 16 6	February and August	11⅛	...
6,000	10	10%	Do. Preference 10%	17½ 18½	17½ 18½	5 8 1	,, ,,	...	...
12,931	5	2/4¼	Direct Spanish (£4 paid)	4 4½	4 4⅛	4 8 11	March & September	...	...
6,000	5	10%	Do. Preference 10%	9 10	9 10	5 0 0	April and October	9 1/16	...
60,710	20	3/6	Direct United States	10⅛ 10⅜	10⅛ 10⅜	6 15 0	Jan., Apr., July, Oct.	10⅜	...
880,000	10	2/6	Eastern	14 14½	14 14½	4 11 3	,, ,,	14½	14
70,000	10	6%	Do. 6 per Cent. Preference	14⅜ 15¼	14⅜ 15¼	3 18 8	,, ,,	15 1/16	14⅛
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock	106 108	106 108	3 14 1	May and November.	108	106⅞
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	106 109	106 109	4 11 9	February & August	108½	108
250,000	10	2/6	Eastern Extension	14 14½	14 14½	4 11 3	Jan., Apr., July, Oct.	14½	14
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	100 102	100 102	5 17 8	February & August	100½	...
473,000	100	5%	Do. 5 per Ct. (Austln. Gov. Sub.) Debs. 1900	102 105	102 105	4 15 3	January and July	...	...
179,177	10	1/9	Globe Telegraph and Trust	8⅝ 8⅞	8⅝ 8⅞	6 1 1	Jan., Apr., July, Oct.	8⅞	8½
178,992	10	6%	Do. 6 per Cent. Preference	14⅝ 14⅞	14⅝ 14⅞	4 0 8	,, ,,	14½	14⅜
150,000	10	5/0	Great Northern	15 1/16 16	15½ 16	4 13 6	Jan., July, and April	...	...
17,000	25	12/6	Indo-European	41 43	41 43	5 16 3	April and October	...	...
9,000	8	4/0	Reuter's	7 7½	7 7½	5 6 5	April and October	7¼	...
15,609	10	3/6	West African Telegraph	9½ 10½	9½ 10½	...	...	...	...
300,000	100	5%	Do. 5 per Cent. Debentures	98 101	98 101	4 19 0	March & September	100½	100
30,000	10	5/0	West Coast of America	10½ 10⅝	10½ 10⅝	5 11 4	January and July	...	...
150,000	100	8%	Do. Debentures 8%	121 126	121 126	6 7 0	June and December	...	...
88,321	10	nil.	West India and Panama	3½ 3½	3½ 3½	...	...	3⅜	3⅛
34,563	10	12/0	Do. 1st Preference 6%	11½ 12	11½ 12	...	April and October	11⅞	11⅜
4,669	10	10/0	Do. 6 per Cent. 2nd Preference	14⅛ 15½	14⅛ 15½	...	...	...	...
45,181	15	6/0	Western Brazilian	10½ 10⅝	10½ 11	6 16 6	May & November	10⅝	...
$1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	122 126	122 126	5 11 1	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	99 101	99 101	5 18 10	March & September	...	...
			TELEPHONES.						
224,850	14/0	5%	Consolidated Telephone and Maintenance	1/16 1/8	1/16 1/8	5 12 0	Yearly	1/8	1/16
220,000	£1	3%	Oriental (11s. paid)	1/16 1/16	1/16 1/16	3 5 11	...	...	...
80,000	5	3/0	National	5 5¼	5 5¼	...	June and December.	5¼	5
55,000	5	2/0	United River Plate	4½ 5	4½ 5	...	January and July	...	...
								...	...
			ELECTRICITY SUPPLY COMPANIES.						
555,000	5	...	London Electric Supply	2⅝ 2⅞	2⅝ 2⅞	...	...	...	...
500,000	10	...	Metropolitan Electric Supply (£6 paid)	5½ 6	5½ 6	...	...	5⅞	5 1/16
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
190,248	3	...	Brush Electrical Engineering	...	2¼ 2⅛	...	...	2¼	...
353,478	5	7%	Edison and Swan United	...	...	...	...	...	...
409,000	10	...	Electric Construction	10⅛ 10⅜	9⅞ 10¼	...	...	...	...
140,000	2	...	Elmore's Patent Copper Depositing	...	4⅜ 5¼	...	...	5 3/16	3 13/16
41,600	10	10/0	India Rubber, Gutta Percha & Telegraph Works	17½ 18½	17½ 18½	5 8 1	February & August	18½	...
78,949	5	6%	Swan United (£3. 10s. paid)	4¼ 5¼	4½ 5	4 3 11	...	4⅝	4¼
57,850	12	36/0	Telegraph Construction and Maintenance	43 45	43 45	5 6 8	March and July	45	44

JABLOCHKOFF'S
DISTRIBUTION PATENT

(Being a Patent for "Producing and Dividing Electric Light," No. 1996 of 1877.)

THE
ELECTRICAL ENGINEERING CORPORATION, Ltd.

(STATTER'S) Are Proprietors of the above Patent, and Warn the Public against Infringement. (UNITED).

The following are Licensees:—

Brush Electrical Engineering Company, Limited.
Crompton & Co., Limited.
S. Z. de Ferranti.—London Electric Supply Corporation, Limited.
W. T. Goolden & Co.
Hammond & Co.
Wilson Hartnell.
Johnson & Phillips.
Laurence, Paris & Scott, Limited.
Nalder Brothers & Co.
Paterson & Cooper.
Ernest Scott & Co.
Siemens Brothers & Co., Limited.

3, Prince's Mansions, Victoria Street, Westminster. PERCY E. SCRUTTON, *Secretary*

Digitized by Google

THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 621.—Vol. XXIV. FRIDAY, APRIL 11, 1890. Price Fourpence.

NOTES.

It is, perhaps, to be regretted that the points now in dispute between Prof. Forbes and Dr. Harries and Mr. Newman Lawrence were not more completely cleared up in the discussion at the Institute of Electrical Engineers. They are of some interest as bearing indirectly upon the danger respectively of alternating and continuous currents to human life. The authors of the Paper do not seem to have had this fact sufficiently in view, if, as stated by Mr. Lawrence, the Paper dealt "exclusively with phenomena after contact." Assuming, however, the contact to be momentary and equally good in each case, what we want to know is the relative physical effect of a continuous and alternating current of the same strength. A letter which appeared in *The Electrician* of January 25, 1889, may now be read with interest, since the writer draws from the fact that a slowly-alternating current is more painful than one which alternates more rapidly, an inference different from that to which Mr. Newman Lawrence seems to incline. The shocks being least bearable when slowest, argued "Telegraphist," it is the single sharp shock that hurts, if allowed to take full effect before reversal; and consequently a powerful stroke from a continuous current will do more harm than a rapidly-reversed current of like force. True, you may continue a comparatively weak alternate current till the resistance of the body is broken down, and the current becomes unbearable; but this is not the manner in which death is inflicted by electric lighting currents; nor is it proposed to be tried in that way on capital offenders at New York. In most cases where fatal results have ensued, the mischief was done at the moment of contact; and the writer of the letter above referred to is apparently of opinion that if he had to take the risk of a strong current through his body, he would rather "take it alternating."

Accumulators of the Planté type are now receiving a considerable amount of attention. M. Pollak has recently communicated to the *Comptes Rendus* some researches undertaken with the object of giving such cells a large capacity after a short time of forming. With this view plates are covered with spongy lead obtained electrolytically, and to ensure perfect adherence the plate surfaces are previously worked so as to present a brush-like appearance. The plate, after having been washed free from fatty matters, is coated with a paste of sulphate of lead and plunged into acidulated water between two plates of zinc. The forming is accomplished in 50 hours by passing the current through in one direction. The negative plates have then a greyish appearance, while the positives are deep brown. After the formation the adherence of the active material, consisting of spongy lead and binoxide of lead, is so good that the adhering surface of the superposed layer is indistinguishable. Such an accumulator, consisting of nine plates, four positives and five negatives, with a total weight of eleven kilogrammes, after 45 hours' forming, with a current of 16 amperes, gave, during a discharge kept constant at 18 amperes, a capacity of 95·4 ampere-hours. The initial potential was 2·12 volts, this falling slowly to 2 volts after four hours, and then more rapidly to 1·8 volts after a little over five hours. The same accumulator recharged with a current of 16 amperes for seven hours gave during the discharge 102·3 ampere hours, showing an efficiency of 91·4 per cent. and a capacity of 9·13 ampere-hours per kilogramme of lead. This capacity does not compare unfavourably with that of cells of the E.P.S. type; and if such cells are durable there should be a future for them. It is, however, impossible to test the efficiency of secondary batteries from a single charge and discharge; and, moreover, the watt-hour should be taken as the unit of measurement, since very anomalous results may be obtained from estimating the ampere-hour efficiency.

Observations on the ratio of luminous to non-luminous radiation emitted by various sources of light are of some interest to electricians, as, even in the arc lamp, which is far more efficient than any other light, the proportion is very small, and it is thus possible, theoretically, to greatly improve existing methods of lighting. It is known from experiments of Prof. Nichols that for the arc lamp only about 10 per cent. of the radiated energy is luminous, while, for the incandescent lamp, the ratio is 5 per cent.; and, according to Thomsen, the proportion for the candle, the oil lamp, and the gas flame is about 2 per cent. each. Experimental determination of the ratio is, however, difficult, and different authorities give very varying results. The radiation emitted from an Argand gas burner has recently formed the subject of careful research by Sir John Conroy, a description of whose experiments appears in the February number of the *Proceedings* of the Royal Society.

The radiation emitted by the Argand flame was allowed to fall on the face of a thermopile, either directly or after passing through different thicknesses of water or alum solution, contained in a cell with glass ends. In the former case the whole energy was measured, while, in the latter, only those rays affected the thermopile which were unabsorbed by the

Digitized by Google

liquid cell. In some preliminary experiments it was shown that there was no measurable difference between the absorbing power of water and alum solution, and that when the length of the liquid was 15 cm., or more, the transmitted radiation consisted almost entirely of light rays. The result obtained by Sir JOHN CONROY was that the radiation from an Argand gas burner consisted of 1·75 per cent. luminous and 98·25 per cent. non-luminous radiation.

THE American telegraphic journals are now discussing the widespread discontent which is manifesting itself among the telegraph operators in the United States, and speak of the possibility of a great strike. Curiously enough, the low rate of wages and long hours prevalent in that country, and the consequent discontent, are due to there being a glut of competent operators out of employment, owing to the amalgamation of the companies and the absence of sharp competition. The attractions of telegraph employment in recent years have resulted in the training of more telegraphists by far than can get situations. It is to be hoped they may find employment of another kind. Until then, the working telegraphists had better think twice before they strike, and change places with their less fortunate brethren.

MR. GRAFF BAKER'S letter in the *Financial News* of Tuesday is a mere re-echo of the leading article on the subject of electric traction which appeared last week in that journal. The communication is mainly devoted to retailing once again the oft-told story of the rise and progress of electric traction in the United States. All that Mr. BAKER, after nearly twelve months' active work, is able to tell us with regard to electric traction in Great Britain is that "A company is in progress of formation which will materially assist the introduction of electricity in the place of steam as well as horses. This company, when ready for business, will be prepared to put down the necessary plant and equipment for the operation of any given road, and to furnish the power at a price per car mile, varying according to conditions, never to exceed the present cost of working, whether by steam or horses; and, should electrical traction become as popular on this side as it has already in the States, I should not be surprised to see the profits of this company exceed those of our own (the Thomson-Houston International Electric Company)." Up to the present, this process of company formation has in this country exhausted most of our energy—and money.

Now that electricity and its varied industrial applications have become a stock subject for popular articles in the monthly magazines, it is certainly satisfactory to find that the writing of these educational disquisitions is being more and more confided to those who know what they are writing about. Amongst other articles in the magazines for the current month is one in *Scribner's* by Mr. JOSEPH WETZLER, on "The Electric Railway of To-day;" and another by Mr. A. A. CAMPBELL SWINTON on "The Present Position of Electric Lighting," which appears in *Murray's*. Mr. WETZLER'S is one of the best popular articles on electric traction that we have seen. A perusal of it would, perhaps, tend to remove any doubts that may linger in the minds of our tramway magnates as to the capabilities of electricity, though we are afraid that the aerial spider's webs shown in several illustrations would tend to counteract the persuasive effect of the 210 per cent. net increase in the earnings of the tramway at Davenport, Ia., which it is affirmed resulted from the adoption of electric traction. Mr. SWINTON confines himself to a plain and business-like exposition of the cost of electrical installations. He points out at the conclusion of his article that any great reduction in the present price of electricity, apart from the increased economy consequent upon large-scale working, must be looked for in the direction of cheaper, more durable, and more efficient glow-lamps.

"A WORD is urgently required for immediate use," Lord BURY tells us, in the *Times* of Wednesday, "which shall express progression by electric power." The result of this appeal to the ingenuity of the word-coining fraternity has been a column and a half of more or less cacophonous suggestions in yesterday's *Times*. To "mote," "motor," "electrize," "electrate," "volize," "amber," "tric," and "squirm" are a few of the monstrosities proposed; and in our own correspondence columns will be found a letter from Mr. O. C. D. ROSS, urging the claims of the verb "to faradate." For our own part, we shall be content to wait indefinitely for the word if only we obtain the thing itself.

Edinburgh Exhibition.—Mr. A. R. Bennett has been elected a Vice-Chairman of the Executive Council of the Exhibition.

Carlisle.—The Brush Electrical Engineering Company have abandoned their Provisional Order to enable them to light this city by electricity.

Ipswich.—The Town Council has given consent to the Provisional Order of the Brush Electrical Engineering Company, a draft of which had already been approved by the Council.

Incandescent Lamp Manufacture.—A company has been formed at Birmensdorf, with a capital of 250,000fr., under the title of the Zurich Incandescent Lamp Company, for the manufacture of glow lamps.

Society of Engineers.—Amongst the recently elected honorary members of the Society of Engineers are:—Lord Armstrong, Sir Benjamin Baker, Sir James Douglas, Sir William Thomson, and Mr. William Anderson.

Electric Traction in Germany.—From the *Elektrotechnische Echo* we learn that the Deutsche Strassenbahn-Gesellschaft intend to introduce electric traction on their lines, but have not yet decided on the system to be adopted.

Brussels.—The Société l'Électrique have just fitted the Palace of the Comte de Flandre with an installation of 900 lights. The lamps are run off Julien accumulators. The number of lights is shortly to be increased to 1,500.

Telephonic Extensions.—Two new trunk wires between Dundee and Forfar have just been completed, and the trunk wires for Brechin, Montrose, and Aberdeen are almost finished on the section between Dundee and Forfar.

Bath.—On Saturday last the final trial run of the machinery and engines at the Electric Light Works took place; and this week the lighting of the various shops, hotels, and private houses where the fittings are completed commenced.

University College, Bristol.—The third term of this College commences on April 29th. A course on electrical engineering, comprising electric lighting, dynamo-electric machinery, and transmission of power, will be held during this term.

Digitized by Google

Galway.—The Galway Harbour Commissioners have accepted the tender of the Galway Electric Company to light the old and new docks with electric light. The water-power of the Corrib River is being utilised for the production of the electric light.

The International Telegraph Congress.—The International Telegraph Congress is to open in Paris on May 15th. It will be held, says the *Times*, in the Prince Imperial's riding hall at the Louvre, and the work of clearing out the hall and preparing it for the Congress has begun.

Electroculture.—A report on the subject of electroculture was presented to the sixth Congress of Russian Naturalists, by M. Specnew. There was considerable proof, he said, that the use of electricity reduced the diseases of plants caused by micro-organisms to a minimum.

Electrical Installation Regulations in Spain.—A royal decree, dated 14th March last, has been issued by the Spanish Colonial Minister, establishing the conditions relating to electrical installations. The full text of the decree is given in the *Industria é Invenciones* of April 5th.

The Popp System.—According to the *Electrotechnische Zeitschrift* tests of the Popp system will be conducted at the Frankfort Exhibition. The above-named paper maintains that the efficiency of the system is only 15 per cent.; but Mr. Popp, in a letter to the *Finanz Herald*, asserts that it is 75 per cent.

National Telephone Electrical Society.—On March 21st Mr. A. H. Church read before this Society a Paper on "Telephony Abroad," in which he treated at length the Van-Ryssel-berghe system and duplex telephony. On the 28th Mr. W. A. Baxter read a Paper on "Inspection of Telephone Instruments."

A Correction.—Our Boston contemporary *Modern Light and Heat* is good enough to point out that on page 473 of our issue of March 14th, by a slip of the pen, we attributed Prof. Elihu Thomson's recent Paper on "Safety and Safety Devices in Electric Installations" to his well-known coadjutor Prof. Houston.

Society of Arts.—Amongst the Papers for the Wednesday evening meetings to the end of the Session are the following: May 7, "The Aim and Scope of Higher Technical Teaching," by Dr. Percy F. Frankland; May 14, "Professor Elihu Thomson's Electro-Magnetic Induction Experiments," by Dr. J. A. Fleming.

Royal Institution.—At the last general monthly meeting of the Royal Institution Major-General C. E. Webber, C.B., was elected a member. The special thanks of the members were returned for the following donations to the fund for the Promotion of Experimental Research:—Ludwig Mond, Esq., £100; Lachlan M. Rate, Esq., £50.

The United States Postal Telegraph Bill.—Mr. J. M. Seymour, a member of the New York Stock Exchange, has, says the *Financial News*, informed the Congressional Committee on Post Offices that he is prepared to establish a postal telegraph at the terms and rates proposed in the Postmaster-General's Bill, or a uniform rate of 25 cents per message.

Craiova (Roumania).—The firm of Egger and Co., of Vienna, are negotiating for the lighting of Craiova by electricity. They seek a 45 years' concession, and propose to charge 4 centimes per 16 candle-power lamp-hour to the municipality, and 6 centimes to the public. The municipality promise to take up 800 lamps, and the scheme is now before the Roumanian Parliament.

Electrical Competitions.—The following electrical competitions are announced for this year by the Société d'Encouragement:—The Melsens prize of 500fr., to be awarded for an application of chemistry or physics to electricity; a prize of 3,000fr., for a method of transporting natural energy to a distance; a prize of 2,000fr., for a commercial method of preparing ozone, and for making practical use of it.

The Electric Light on the Warship "Le Hoche."—The electrical installation on board the French battleship "Le Hoche" comprises 4 14-unit (70 volts × 200 amperes) Desroziers' dynamos, running at 350 revolutions, driven by Breguet compound engines, through Raffard elastic coupling. The lights comprise 6 projectors, taking from 65 to 75 amperes, and 14 50-candle-power, 23 32-candle-power, and 350 10-candle-power 65-volt incandescents.

Abandonment of Metropolitan Electric Lighting Schemes.—The following Electric Lighting Orders will not be proceeded with:—St. Martin's-in-the-Fields and Strand; St. Margaret and St. John the Evangelist, Westminster; City of Westminster Electrical Syndicate; St. Pancras Electric Supply. The first-named Order was applied for by Messrs. Gatti; the second, by Messrs. Renshaw, King, and Co.; the other two by the syndicate named, and by the House-to-House Company.

Bradford Scientific Association.—At the last meeting of this Association a Paper was read by Mr. Sydney Baynes, A.I.E.E., Managing Engineer of the Bradford Corporation Electric Light Department, on the "Progress of Electric Lighting." The lecturer described the gradual development of the dynamo, arc and incandescent lamps; and in the course of his remarks briefly touched upon the leading central stations at home and abroad. Diagrams and apparatus were used to more fully illustrate several points connected with electrical progress.

St. George's (Hanover-square) Vestry.—At its last meeting this Vestry sanctioned the laying of electric mains by the Westminster Electric Supply Corporation under the footways, upon condition that if any of the inhabitants in front of whose property the lines are laid obtain the sanction of the Vestry for the construction of vaults under the footway, the Corporation shall, after one month's notice from such inhabitant, remove the main into the carriage-way to enable the vault to be constructed, and that in future similar applications be granted subject to a similar condition.

The London Subways and Overhead Wires Bill.—At the last meeting of the London County Council the Parliamentary Committee reported that in concert with the Highways Committee they had considered the thirty-seven petitions presented against this Bill, and that, having regard to the attitude of uncompromising opposition to the project taken up by so many of the companies, they recommended that the Bill should not be proceeded with this Session. They recommended, however, that the part of the Bill which relates to overhead wires should be proceeded with. The recommendations were agreed to.

Social Gathering of Yorkshire Telephonists.—On Friday evening, March 21st, the staffs of the various centres in the Yorkshire District of the National Telephone Company assembled to spend a social evening at St. James's Hall, Leeds. Previous to the gathering a gold watch was presented to Mr. J. C. Chambers, late General Manager for the Yorkshire District, by Mr. James Holroyd, of Halifax, on behalf of the united staffs, as a token of the high esteem in which he was held by them during the many years of his connection with the district. Mr. Chambers has recently removed into the Lancashire district.

Beckenham Local Board.—The representatives of the Local Board had a conference a few days ago with the Board of Trade and the promoters of the Crystal Palace District Electric Lighting Order; and a satisfactory arrangement was come to, with the exception of one of the clauses which had reference to the transferring of the Order. The Board of Trade absolutely prohibited the assignment of the Order. Upon the question of purchase it was finally agreed that a clause should be inserted by which the Beckenham Local Board will have the right of purchase after a period of seven years and within fifteen years by paying 33 per cent. in addition to the capital actually expended on the undertaking, the power of purchase being entirely at the option of the Board.

Exports of Telegraphic Wires, &c.—The Board of Trade returns, issued on Wednesday, give the totals of the exports of telegraphic wires and apparatus connected therewith for the first quarter of the current year. Up to the end of February last this year's exports had shown a decided improvement; but, owing to very large shipments in March last year, the quarter's

Digitized by Google

figures do not compare quite so favourably. The following is a comparative statement of the monthly exports during the first quarter of the current and two previous years :—

	1890.	1889.	1888.
January	£71,686	£113,230	£41,231
February	201,594	32,086	14,051
March	51,390	285,993	32,795
	£324,670	£431,309	£88,077

Electrical Apparatus for the Transvaal.—We announced some time ago that a large installation for the electric transmission of power was being manufactured by the Sprague Company for the Forbes Reef Gold Mining Company of South Africa. The Forbes Company are now so satisfied that electricity is the most convenient and economical agent for transmitting power over long distances, and applying it at its point of use, that the managers of that Company have ordered additional apparatus for the transmission of 75 more horse-power. This will make a total of 215 horse-power to be transmitted. The efficiency of the whole system will, it is said, be about 70 per cent.. Part of the apparatus has already been shipped to the Transvaal. When this is finished it will be one of the largest electric mining transmission plants in the world.

The Electric Light in Military Operations.—In a recent Paper, read before the Société d'Encouragement M. Lemonnier stated that when beams of light from the Mangin projectors on the top of the Eiffel Tower were thrown in the direction of the Sèvres Valley, observers placed at a distance of 2,000 metres from the spots illuminated by the rays were able to clearly distinguish small objects, such as animals and human beings; even when the illuminated region was 10,000 to 11,000 metres ($6\frac{1}{4}$ to $6\frac{3}{4}$ miles) from the source of light. M. Lemonnier then pointed out the great importance of these facts in connection with the defence of entrenched positions and fortified towns, and said it was the opinion of many military officers that the use of noiseless and smokeless powders would increase the tendency to night attacks. The Parsons turbo-dynamo had, he said, made available a very suitable means of generating electricity for military purposes.

Electricity and the Mariner's Compass. — Lieut. W. H. Schuetze, the superintendent of compasses of the United States Navy, is led to believe, from observations on board steel vessels that no reliable compass data can be gathered unless the vessel is in dry dock. It has been the practice to undertake these observations while the vessel is in the water; but, under these circumstances, it always has more or less motion, which seriously affects the results. The deflections produced on compass needles by the dynamos used for electric lighting are, he reports, in some cases, as much as 2deg.; and the superintendent recommends that the position of the dynamos should be a secondary consideration to that of the compasses. About 40ft. has been considered a safe distance between dynamos and compasses; but in determining this question the induction of magnetism in bulkheads and other vertical as well as horizontal steel and iron must not, Lieut. Schuetze remarks, be overlooked.

Marylebone Vestry.—At a meeting of this vestry last week the Works Committee recommended, as to a communication received from the Metropolitan Electric Supply Company, giving notice of the Company's intention to lay cables connecting Rathbone-place generating station with the Manchester-square station, "That the Vestry permit the work to proceed at once, provided the Company agree to remove their pipes at the Company's expense, where any owner wishes to reconstruct his vaults." This was opposed by Sir Edwin Galsworthy, who moved as an amendment, "That the Vestry object to the work proceeding unless the Company agree to abide by the resolution passed by the Vestry on the 6th ult.," which was to the effect that "in the event of any owner of property wishing to construct cellars or vaults under the footway, the Company shall remove their mains, at their own cost, within six weeks of any such notice, into the carriage-way." This amendment was put to a division, and, finally being carried, became the substantive motion, and was agreed to.

The Electric Launches at the Edinburgh Exhibition.—The four launches which will run in the canal at Edinburgh are designed by Messrs. Morton and Williamson, and built by T. B. Seath and Co., Glasgow. They are 40ft. long, 6ft. 6in. wide, and draw 2ft. 1in. They have a carrying capacity of 40 passengers. The electrical equipment has been supplied by Messrs. Immisch and Co., and is similar to that used on the Thames launches. The charging plant will consist of a 25 horse-power engine and an Immisch dynamo, with suitable switch arrangements for charging four launches at the same time. The motors are capable of an output of about $3\frac{1}{2}$ brake horse-power, at 800 revolutions per minute. The propellers are coupled direct to the motor shafts. A ball-bearing thrust-bearing is attached to the motor-bed, and is constructed in combination with the plain bearing of the motor. This arrangement is the invention of Messrs. Immisch and Co., and has been patented by them. By its use the friction is reduced to the minimum, and there is no noise or vibration. The high-speed propellers have been made after a careful course of experiments, and give the highest efficiency hitherto attained with such small blades. They are designed for going both ahead and astern. The steering, starting, and reversing gear are so arranged that one man has the launch entirely under control.

The Electrical and Magnetic Disturbances at the Paris Observatory.—The efforts of the Director of the Paris Observatory to modify the direction of the proposed extension of the Sceaux line have, says *La Lumière Electrique*, made public some very curious phenomena. The Observatory is situated between two busy suburban lines, namely, the Chemin de Ceinture, which is only 60 metres away, and the Sceaux railway, which is 80 metres distant. The passage of the Ceinture trains causes the bifilar magnetometer needles to oscillate so violently and distinctly that M. Descrois, of the Observatory staff, is in a position to supply the railway company with a sheet checking the time of their trains. The curve of the declination needle, curiously enough, exhibits no traces of disturbance. The bifilar needle is kept by torsion at right angles to the magnetic meridian, and therefore parallel to the motion of the Ceinture trains; and M. Descrois is inclined to think that the observed disturbance is due to the fact that the wheels and axles become strongly magnetised, owing to their movement in the magnetic meridian. The Sceaux trains have no effect on the magnetometer needles; but give rise on the other hand to marked disturbance of the registering electrometers. The station on this line is at a distance of about 100 metres from the Observatory, and whenever the driver lets off steam the electrometer partially discharges, and then immediately afterwards again rises to its normal potential. This singular phenomenon takes place no matter what the potential of the atmosphere may happen to be.

An Erratic Lightning Flash.—During a thunderstorm at Larnaca the entrance door of a house occupied by one of the Eastern Telegraph Company's *employés* was struck by lightning. The woodwork round the iron lock on the inside of the door and down to the top step of a flight of stone steps was completely splintered, and the lock was almost wrenched from the woodwork. Attached to the outside wall of the house was an iron stove-pipe, reaching considerably above the roof. No trace whatever could be found of this having been touched, and nothing inside or outside of the house showed any sign of an electrical discharge except the door. Within a stone's throw of the house in question are the buildings of the Anglo-Egyptian Bank, with a lightning rod of considerable altitude; also, quite close, are several high consular flagstaffs. None of these were touched. In the immediate vicinity are several iron telegraph poles, with lightning rods attached, and not far distant are several mosque minarets of great height, with metal caps. None of these were touched. It is difficult to understand, on the principle of the "protected area," why the flash struck the door almost on a level with the street instead of the iron stove-pipe, or the adjacent lightning rod, or the flagstaffs, telegraph poles, or minarets; or why it did not make direct earth in the muddy and flooded street within a few feet of the wooden door? Again, the houses adjoining and on the opposite side of the street—a narrow one—are built of sun-dried mud bricks, and these were saturated with rain, making capital earth; yet they escaped. The house of which the door was struck is built of trimmed blocks of stone.

Digitized by Google

MAGNETISM IN IRON AND OTHER METALS.*—XIII.

BY PROF. J. A. EWING, F.R.S.

(*Continued from page 545.*)

§ 61. **Example of the Ballistic Method.**—In the following example† the specimen was a ring welded out of a piece of moderately soft annealed iron wire :—

Diameter of wire forming the ring.....	0·248 cms.
Area of section of iron.....	=0·0483 sq. cms.
Mean radius of ring 5·0cms.	Mean circumference 31·4cms.
Number of turns in magnetising coil...	474
Number of turns in secondary coil.....	167
Area of earth-coil	1216 sq. cms.
Number of turns in earth-coil.....	10
Earth's force, cut by earth-coil	0·34
Ballistic throw on turning over earth-coil	42·9 scale div.

The mean value of the magnetic force per ampere was, therefore :—

$$\frac{4\pi \times 474}{10 \times 31{\cdot}4} \text{ or } \frac{2 \times 474}{10 \times 5{\cdot}0} = 18{\cdot}96.$$

The resistance of the secondary circuit was not altered throughout the experiment, and the correction for air-space within the secondary coil was negligible. Hence, from the above data, the change of the induction **B** per square cm. in the iron corresponding to one scale division of ballistic throw was—

$$\frac{1216 \times 10 \times 0{\cdot}34 \times 2}{0{\cdot}0483 \times 167 \times 42{\cdot}9} = 23{\cdot}89.$$

The experiment consisted in applying first a weak magnetic force, and increasing it by a series of sudden steps to 9·14 C.-G.-S. units, and then removing and finally re-applying the same force, all by steps, while the ballistic throws were observed. The following Table III. gives the results, μ, **I**, and κ having been calculated from **B** and **H**.

TABLE III.

H.	Ballistic Throw.	Sum of Throws.	B.	μ.	I.	κ.
0·13	1·1	1·1	26	...	2	...
0·26	1·1	2·2	53	...	4	...
0·30	0 5	2·7	65	...	5	...
0·40	0·8	3 5	84	...	7	...
0·53	1·0	4·5	107	...	9	...
0·71	2·1	6 6	158	...	12	...
0·93	2·9	9·5	227	...	18	...
1·31	3·9	13·4	320	245	25	19
1·69	9·2	22·6	540	320	43	25
1·89	6·9	29·5	705	370	56	30
2·78	77·5	107·0	2,560	920	203	73
3·36	78 7	185·7	4,440	1,320	353	105
4·01	82	267·7	6,400	1,600	509	127
4·95	91·5	359·2	8,580	1,740	683	138
5 86	57	416·2	9,940	1,700	791	135
7·20	57	473·2	11,300	1,570	899	125
8·10	23·5	496·7	11,870	1,460	944	116
9 14	24	520·7	12,440	1,360	989	108
7·83	− 4·4	516·3	12,330	...	981	...
6·21	− 6·7	509·6	12,170	...	968	...
4·75	− 7·1	502·5	12,000	...	955	...
2·70	−14·0	488·5	11,670	...	929	...
0	−33·2	455·3	10,880	...	866	...
2·78	15	470·3	11,240	...	894	...
4·95	14·2	484·5	11,570	...	921	...
6·21	11 9	496·4	11,860	...	943	...
8·00	14 5	510·9	12,170	...	971	...
9·14	10	520·9	12,440	...	990	...

The relation of **B** to **H** in this experiment is shown in Fig. 29. It will be seen that the curve of magnetisation presents the same characteristics as in the former example. The residual value of **B** is 88 per cent. of the induced value.

* All rights are reserved.

† *Phil. Trans.*, 1885, pp. 530-532.

§ 62. **Ballistic Method using Reversals : Magnetisation of an Iron Ring (Rowland).**—A few more examples may be quoted in further illustration of the relation of magnetisation to magnetising force in iron.

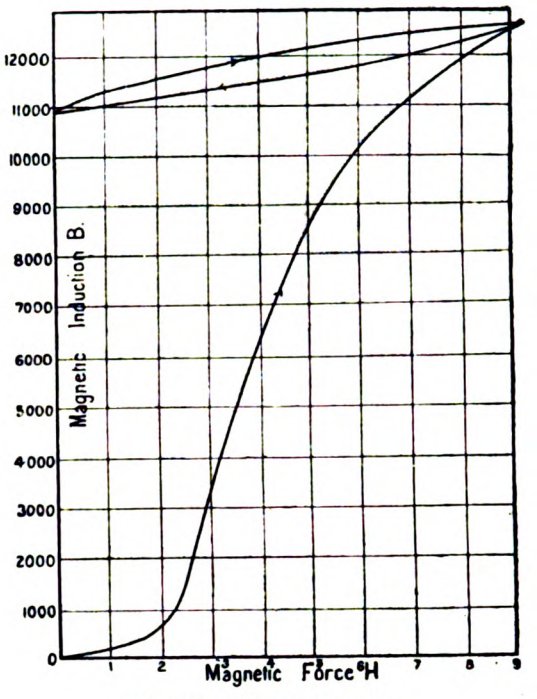


FIG. 29.—Wrought-Iron Ring.

In the following experiment by Rowland* the specimen was a welded and annealed ring of "Burden's Best" wrought iron, 6·77cm. in mean diameter and 0·916 sq. cm. in section. **B** was measured by reversing the magnetising current and taking half the ballistic effect. The ballistic effect of breaking the magnetising current was also noted. This, subtracted from half the effect of reversal, gave the residual magnetism at each stage in the magnetising process. The results, reduced to C.-G.-S. units, are given in Table IV.,† where the residual values of the magnetic induction appear in the third column under the heading B_r.

TABLE IV.

H	B	B_r	μ
·18	71	18	390
·69	600	211	869
·86	967	439	1,129
1·27	2,460	1,570	1,936
1·41	2,920	1,940	2,078
1·45	3,080	2,060	2,124
2 04	4,960	3,630	2,433
2·22	5,480	3,810	2,470
2·34	5,780	4,010	2,472
2·72	6,650	4,750	2,448
3·16	7,470	5,430	2,367
4·05	8,940	6,270	2,208
5·31	10,080	6,840	1,899
8·48	12,270	7,500	1,448
10·23	12,970	7,670	1,269
11·99	13,630	7,520	1,137
17·69	14,540	7,990	824
34·17	15,770	8,130	462
46·02	16,270	7,850	354
64·33	16,600	7,890	258

* *Phil. Mag.*, Vol. XLVI., 1873, p. 151.

† The dimensions of **H** and of **B** and of **I** are $\frac{(\text{Mass})^{\frac{1}{2}}}{(\text{Length})^{\frac{1}{2}}\,(\text{Time})}$. Rowland, in the Paper cited, uses *metre*-gramme-second units in expressing the induction. His numbers (called Q in the Paper) have therefore to be divided by 10 to bring them to C.-G.-S. units. With regard to **H**, he gives (under the heading M) numbers which are equal to the magnetic force divided by 4π. These have accordingly to be multiplied by $\frac{4\pi}{10}$ to reduce them to C.-G.-S. units of **H**.

Digitized by Google

Fig. 30 shows these values of **B** and $\mathbf{B}_r$ in relation to **H**, for forces up to 10 C.-G.-S. Beyond that force, the residual magnetism becomes very nearly constant. The proportion of residual to induced magnetism is considerably smaller here

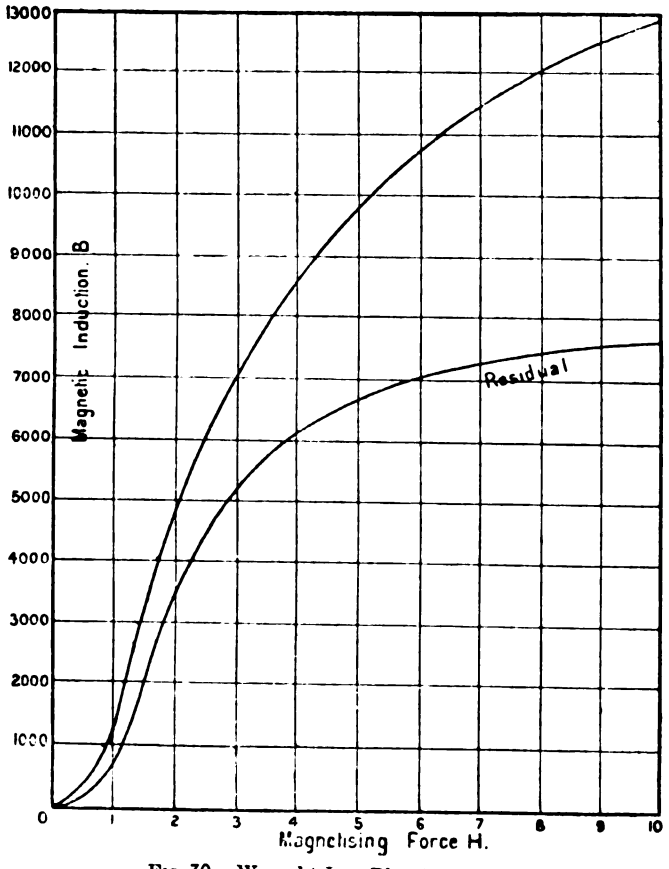


Fig. 30.—Wrought-Iron Ring (Rowland).

than in experiments with long wires or with wires welded into rings. Probably this is due less to any specific difference in the material than to a difference in the conditions of the experiment. It was shown long ago by Von Waltenhofen that when magnetic force is suddenly removed from an iron rod it leaves less residual magnetism than when gradually removed.* This is notably the case when the specimen is comparatively thick. In a thick rod or ring the sudden with-

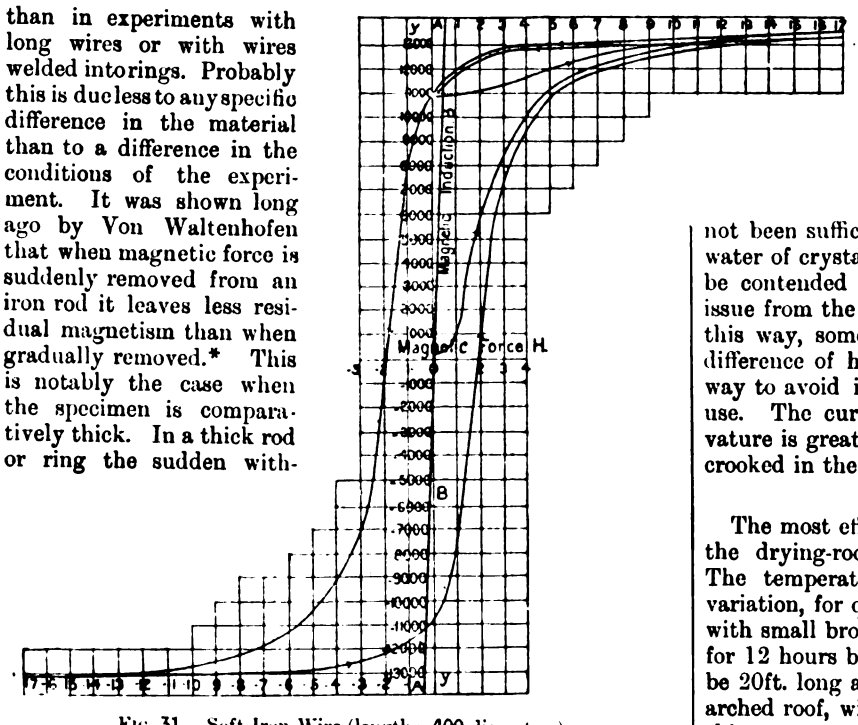


Fig. 31.—Soft Iron Wire (length = 400 diameters).

drawal of magnetic force sets up oscillating circumferential currents in the substance of the metal, which have an effect not unlike that which is produced in the process of "demagnetising by reversals" (§ 42). With very long wires or rings of small section one commonly finds 80 or 90 per cent. of the induced magnetism survive the removal of magnetising force, especially when the force is reduced by small steps or quite continuously. In the present case the force was removed suddenly, and the ring was thick.

§ 63. **Cyclic Process of Magnetisation: Long Iron Wire.**—In this instance the specimen—a straight wire of very soft annealed iron, 0·158 cms. in diameter and 64 cms., or 400 diameters, long—was tested by the step-by-step ballistic method,* the magnetic force being first raised from zero to 17·26 units, then reversed to −17·26, then reversed again to +17·26, then reduced to zero, and finally restored to +17·26. The effect of these cyclic processes are exhibited in Fig. 31 sufficiently to make it unnecessary to quote the numerical values of **B** and **H**. At the beginning the wire had a small amount of initial magnetism, which was found by slipping off the secondary coil.

In this figure the magnetising force of the solenoid is accepted as the whole magnetic force **H**, no correction having been made for the influence of the ends. If we treat the rod as equivalent to an ellipsoid 400 diameters long, **H** is to be measured from the line O A instead of from O Y.†

On both sides of the figure the residual magnetism is 82 per cent. of the induced, and the reversed magnetic force required to remove it—the "Coercive Force," § 47—is 1·9. This figure is thoroughly typical of the behaviour of soft wrought iron when subjected to cyclic reversals of magnetic force.

(To be continued.)

ELECTRIC ARC LIGHT CARBONS.

BY O. G. PRITCHARD.

(Continued from page 546.)

Prior to the discovery of the cause of the lateral fissures referred to at the close of my last Paper, I conceived it possible that this fault might have its origin in the speed of the hydraulic pump. This does not, however, appear to affect the carbons, although a speed of about 40 revolutions per minute would seem sufficient. The second fault we may have to contend with is the sudden appearance of longitudinal fissures, increasing, both in depth and width, a few hours after the carbons have been placed in the drying-room. This is due to the fact that the caramel has not been sufficiently carbonised, and still retains some of the water of crystallisation. The third and last fault which has to be contended with is the curving of the carbon rods as they issue from the press; sometimes only a few carbons are affected this way, sometimes many. It must be caused, I think, by a difference of hardness in the pugged stuff, and, if so, the best way to avoid it will be to have the stuff repugged just before use. The curved carbons must be rejected, whether the curvature is great or small. A curved carbon will aways come out crooked in the firing.

Drying-Rooms.

The most efficient and certainly the cheapest way of heating the drying-rooms is by means of the slow-combustion stove. The temperature can then be maintained, without sensible variation, for quite six hours, if the fires are carefully built up with small broken coke, and without renewal ought to burn for 12 hours before extinction. The first drying-room should be 20ft. long and 8ft. wide, and 8ft. to the springing of the arched roof, with the stove in one corner nearest the door. By this arrangement the furthest end of the room is only slightly heated, whilst increased heat obtains near the stove Fig. 7 is a ground plan of the first drying-room. A is an iron sliding

* Pogg. *Ann.*, CXX., 1863. *See* also Wiedemann's *Elektricität*, Vol. IV.

* *Phil. Trans.*, 1885, p. 539.

† By the table in § 33, the value of $\frac{N}{4\pi}$ for an ellipsoid 400 diameters long is 0·000037. Hence the line O A is drawn at such an inclination as to make the reaction of this upon the field equal to a force of 0·37 when B is 10,000.

Digitized by Google

door, B C D the shelving, framed and built up with angle iron, as already described. At the end E (Fig. 8), and on the lower shelf the temperature will remain nearly constant at about 75° F., while the temperature at G will be about 110deg.; at H, nearer the stove, the temperature will be 120deg., and at F, 140° F. These temperatures will always bear a relative proportion to each other, and never vary much.

The carbons are first placed on the shelves at E, removed to G, and after 36 hours to F, where they remain for 12 hours; afterwards removed to the second drying-room and kept for two days at a temperature between 180deg. and 200deg. This drying-room should be much smaller (about 10ft by 8ft.), after which the carbons should be ready for firing. They ought not to be indiscriminately taken, but should be separately handled, as some of the interior carbons may not be sufficiently dry. Their condition is best ascertained by trying to bend them; if they feel the least inclined to bend they are unfit, and must remain until they are fit. Firing before fitness means breakage.

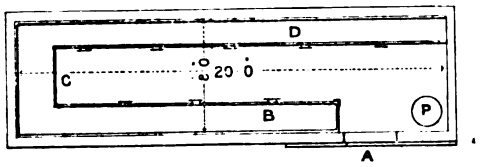


Fig. 7.—First Drying-room (Ground Plan).

I now describe my method of building the kilns. A cleanly but costly system has been tried, but not generally adopted, I believe, of firing carbons by means of gas and atmospheric air combined. The system may be good, but the expense appears to me to be too great. My system is to lay firebrick on the flat, and well grouted with cement; upon which build the two long sides of the kiln B B (Fig. 9), with bricks on edge, well laid in cement, composed of three parts of Stourbridge clay and one part iron grindings. The sludge arising from the grindstone, well mixed, forms a valuable cement, and will not crack under extreme heat. A crack in the kiln admits air, and disintegrates the carbons. The short ends of the kiln are built with bricks on the flat, A A (Fig. 9); the thicker the ends are the better, but 4½in. are sufficient. The kiln must be 2in. longer than the width of two of the plates, and 2in. wider than the length of the plates, which should be 2in. longer than the carbons. This allows for filling in with sieved ashes, which should be kept perfectly dry; any trace of moisture will show itself in the practical disintegration of the carbons.

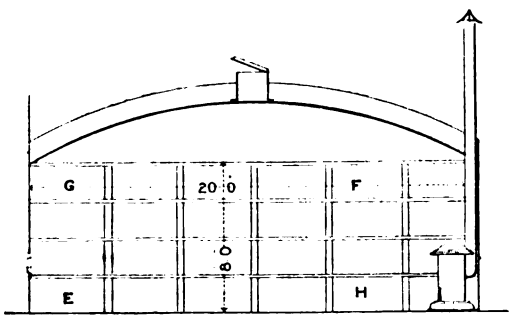


Fig. 8.—First Drying room (Section and Elevation).

The lines at C C (Fig. 9) show the direction in which the carbons are to be packed. The ends A A are made thick to avoid any lateral heat; the fires being made at D D tend to keep the carbon straight. Any heat in the direction of A A would inevitably twist them. After the kilns are packed and covered over to a depth of 2in. with the ashes, the surface had better be covered with a sheet of tin, and built in with firebricks, well filled in between the joints with the prepared cement, and pointed before using the kilns. After construction a fire should be made in and around the kiln, so that it may be perfectly dry when used. The trays in which the carbons are fired must be kept solely for that purpose. The furnace consists of a ring of firebricks, built as shown at E E E E (Fig. 9), with interstices between them of about 2in., E E. (Fig. 10), This circular wall should impinge upon the kiln at F F (Fig. 9), to keep the heat from the sides A A. The bricks are laid loose without cement, and are built to the height of the kiln. The fires must be lighted at D D, gradually adding coke as the fire advances, eventually increasing the height of the walls about a foot higher than the kiln. If the fire was lighted the first thing in the morning, it should not be piled over the top until the evening, and this done only by covering with coke and banking over with cinders and clay. Allow this fire to die out, when

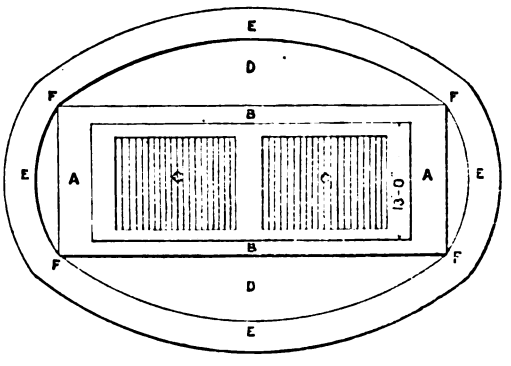


Fig. 9.—Kiln (Ground Plan).

the carbons will be found, on opening, when cold, sufficiently carbonised for the after-process.

The second or final firing has for its object the contraction of the carbon molecules, and increase in density and conductivity. The first firing, however, must be sufficiently prolonged to effect the carbonisation of the caramel, otherwise when placed in the hot saturating bath the carbons would become partially disintegrated. The second firing should be conducted as follows: Bank up as before mentioned in the evening; on the following morning rake out the lower holes all round, and keep a strong fire all day all over the kiln. Bank up partially in the evening, and more completely the following morning. Three days after, on opening, the kiln will be found at a white heat. When it is desired to withdraw the carbons, pull down the retaining wall, and clear away the fire and accumulated ashes, and expose the kiln to the air. Do not open before you can bear your hand on the outside. The top bricks may be taken off, and the kiln emptied, if the carbons are not too hot to hold. I should mention that straight carbons will twist if exposed to the air hot from the kiln; but if once allowed to cool, no after-firing has the least effect upon them. This form of kiln gives out an intensity of heat sufficient to melt wrought-iron, is very easily regulated and modified by blocking up more or less the interstices, and the firing can be prolonged for any length of time by banking up with brick clay, which in itself partakes of the nature of a slow-burning fuel.

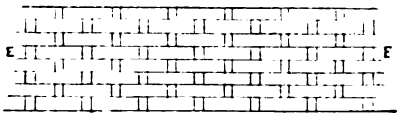


Fig. 10.—Brick wall of Furnace.

The condition of the carbons as they leave the kiln may, in some measure, be determined by the sound emitted when struck one upon another. This sound should be distinctly metallic, the more so the better. This metallic ring increases in the finished carbon to the clearness of a small silver bell; it is only heard in good carbons. A carbon, however, is not necessarily perfect, although the ring may be perfect. It is very desirable to know in what condition the carbon leaves the kiln, to be able to determine what it lacks, and what it requires to perfect it. The feebleness of its metallic ring will indicate that it is soft. If you insert the end of one of these carbons

Digitized by Google

in a clear hot fire until it is red hot, and on taking it ont observe it closely, you will find it smoulder for quite five minutes before it dies out. If you scrape this end with a knife, much carbon powder will detach itself. Observe also the colour of the powder; if reddish, the carbon is impure. The colour of the burnt part of a good carbon is a bluish steel-grey. This holds good for all the best foreign carbons. If the carbon just taken from the kiln had been put in circuit, the current would have made it red hot from end to end, but no arc would have formed for want of conductivity. By imparting increased density to the carbons, these symptoms of an unfinished carbon are altered, and give place to easily recognised signs, which are always the characteristics of a good finished carbon, viz., rapid extinction of the heat after firing the end, and hardness of surface, which becomes as hard as a rod of iron, and does not allow of the surface being disturbed or injured by scraping.

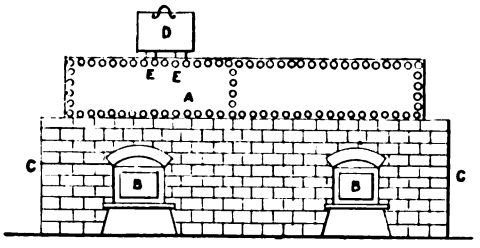


Fig. 11.—Saturating Tank.

Now, to effect this change, the carbons must be saturated, and the operation is carried out as follows:—An iron tank, A, (Fig. 11) is provided, partitioned off at one end to contain hot water, and the tank is placed upon a range, with two fireplaces, B B. Fires being lighted, the tank must be filled to the depth of 12in. with water and a sufficient quantity of sugar to form a syrup. The boxes, D, constructed of tin or zinc, with perforated bottoms, are filled with the carbons packed vertically, and placed in the tank. After boiling half an hour the boxes are removed, and placed upon iron bars, E E, to drain. When cold replace them in the tank, and repeat the process three or four times. Drain them well, and wash the carbons freely in the hot-water end. Remove them when cold (by which the liquor is drawn into the centre) into the third drying-room, and keep them there for 24 hours at a temperature of between 180° and 200° F., after which the whole process may be repeated until the carbons show the characteristics described above of a finished carbon.

Numerous experiments on the different modes of coring enable me to say that the method of coring is of less importance than the condition of the material. A hard core is useless. The best possible form is that of a compressed powder, breaking up easily with the point of a knife; but if too softly packed the current is apt to throw it out, and leave a vacant place which degenerates into a hole, and the light becomes diminished. Three methods of coring will be explained, with diagram of coring machine, in my next article.

(To be continued.)

ON AN ACCIDENTAL ILLUSTRATION OF THE EFFECTIVE OHMIC RESISTANCE TO A TRANSIENT ELECTRIC CURRENT THROUGH AN IRON BAR.*

BY SIR WILLIAM THOMSON.

The wonderful accidental experiment of Lord Armstrong, to which attention was directed in *The Electrician* for March 21, 1890, may be briefly described as follows:—A bar of steel which Lord Armstrong was holding in his hand, was allowed accidentally to come in contact with the two poles of a dynamo giving 85 amperes and 103 volts. A painful sensation of burning was instantly felt, and the bar was dropped. Severe blisters occurred where the hand or fingers touched the bar, which was found immediately afterwards to be quite cold, or not perceptibly hot. This marvellous incident proved: (1) the outer surface of the steel to have been intensely heated; (2) that not enough heat was generated to sensibly warm the whole bar. The explanation, of course, is to be found in the known laws of diffusion of electric currents though non-magnetic conductors, considered in connection with the effect of magnetic susceptibility, of unknown amount and law, in conductors of steel and iron.

The requisites for working out fully the theory of transient or periodic currents in conductors of any form are included in Maxwell's fundamental equations, and are given explicitly for straight cylindric conductors of non-magnetic material in §§ 685-689 of his great work. Lord Rayleigh, in his Paper "On the Self-Induction and Resistance of Straight Conductors" (*Phil. Mag.*, May, 1886), gives the formula for transient or periodic currents in straight cylindric rods of iron, on the supposition of constant magnetic susceptibility. The details of this highly interesting and important branch of the subject have also been investigated by Heaviside in a very comprehensive manner. The tendency of periodically alternating currents to be condensed on the outer part of a cylindric conductor, while the current may be exceedingly feeble or quite insensible in the central parts, was discussed and explained by Lord Rayleigh in p. 388 of his article already referred to, and its aggravation in an iron conductor specially pointed out. The same considerations show that a transient current resulting from the application, for a very short time, of the electromotive force of a voltaic battery, or of electro-magnetic induction acting not directly on the cylindric conductor considered, but on a conductor such as the inductor of a dynamo of any kind, momentarily in circuit with it, is only skin-deep if the duration of the electromotive force be but short enough; and that the depth to which the current penetrates in a given very short time is much smaller for iron than for copper.

To find something towards a mathematical solution for the increasing current at any instant during the electric contact of Lord Armstrong's experiment, it is convenient first to consider the problem of finding the subsidence of current initially given in a circuit of two long parallel bars connected by end bridges, or in a circuit of one long bar insulated, within a conducting sheath, except at its ends, which are in metallic connection with the sheath. If afterwards we suppose the conductors and one end bridge to be given with no current, and that a voltaic battery giving constant potential be suddenly applied instead of the other end bridge, the rise of current through the parallel conductors from its initial zero to its ultimate steady amount will follow *nearly* the same law as the fall from the initial steady current to the final zero in our former simple case. The law will, indeed, be *exactly* the same if the quantity of positive electricity on one conductor, and of negative electricity on the other, requisite to charge them as a condenser in virtue of the gradient of potential, is nothing in comparison with the quantity flowing through the circuit. The quantities of electricity set in motion in consequence of electrostatic and of electro-magnetic induction vary considerably in relative importance, according to the problem considered. For many telegraphic and telephonic problems the static charges are by no means negligible, and in the ocean-cable problem they are of paramount importance, the electro-magnetic induction with which we are now occupied being in this case quite negligible. In shorter cables, and with high-speed action, both the electro-static and electro-magnetic induction must be taken into account, and both have been practically considered by Heaviside in the mathematical theory of the telephone. In the vast majority of laboratory arrangements, the currents required for the static charges are quite negligible, as is also the case with Lord Armstrong's experiment, so that the problem is reduced to considering the natural subsidence of a current under the action of no electromotive forces save those induced by its own rate of change.

In all cases of electric currents given in parallel straight lines, and left to subside, naturally the thermal analogy is most convenient. For electric conductivity, we have thermal capacity divided by 4π; for magnetic permeability, the reciprocal of thermal conductivity; and for current density, temperature multiplied by thermal capacity. Thus, if two infinitely long straight parallel conducting bars, separated by insulating material, be given with equal currents in opposite directions through them, and left to themselves, we have precisely the same mathematical problem to solve as if in every line of the thermal analogue we had initial temperature multiplied by thermal capacity given equal to the current density in the corresponding line of the electro-magnetic problem, and the system left to itself, with the positive and negative temperatures in the two bars subsiding towards zero. The quantity of heat generated per unit of area per unit of time, at any point of either interface in the thermal analogue, is equal to the rate of variation per unit of length along the electric conductor of the electrostatic force in the insulator in contact with it in the electric analogue. The fall of temperature in the latter case will correspond in some respects with the diminution of current in the former, and the rise of current in

* Abstract of Paper read before the Royal Society of Edinburgh, March 17, 1890.

Digitized by Google

different portions of the conductor when suddenly subjected to an applied electromotive force will correspond with the rise of temperature in different parts caused by the sudden exposure of the surface of the body to a high temperature.

Sir William Thomson then considers the case of a bar of circular section surrounded coaxially by a hollow circular cylinder. To further simplify matters he further supposes that the conductivity of the sheath is very great. The problem then becomes mathematically the same as that of a heated cylinder allowed to cool, which was presented and fully solved by Fourier in the sixth chapter of his "Théorie Analytique de la Chaleur." The numerical values to be taken in representation of the various physical properties of the material are then considered. Thus the permeability of the steel is taken as 300 by way of example and illustration; but as the permeability varies enormously with the amount of the magnetising force, and in a manner desperately complicated by hysteresis, no accurate mathematical investigation is practicable with only our present knowledge to guide us. The conclusion arrived at in this particular case is that during the first $\frac{1}{4000}$ of a second, the diffusion is unaffected by the curvature of the conductor, and follows sensibly the law of plane laminar diffusion. The supposition of the circular cylindric sheath of negligible resistance, adopted for the sake of simplicity, may accordingly be departed from, since the solution will be nearly the same for the case of two parallel rods, provided the distance between them is a considerable multiple of the diameter of either. Although the circumstances in Lord Armstrong's experiment are of such extreme complexity that it is of no use to attempt to work out a complete mathematical theory, it seems probable that the solution thus indicated and represented by Sir William Thomson's diffusion diagram* fairly illustrates the circumstances of the current which actually flowed through the steel bar. At all events, ample explanation of the intensity and suddenness of the effect perceived by Lord Armstrong is obtained by working out the result numerically of what would take place if a difference of potentials of 100 volts were suddenly instituted and forcedly maintained constant during one, two, or three ten-thousandths of a second between the ends of the bar.

It must not, however, be supposed that the difference of potential between the ends of the bar was in reality constant at 100 volts, even for so short a time as this. What was really constant was the strength of current through the electrodes leading from the complex dynamo circuit of armature, and shunt and series coils of the electromagnet, to the external lighting circuit, and to the temporary circuit through the steel bar. The immense quasi-inertia of each partial circuit within the dynamo prevented any great augmentation of the outgoing current during the few hundredths of a second during which the short-circuit occurred, and, with probably no practical error, it may be supposed that the outgoing current was constant at 85 amperes, the electric lighting circuit losing as much current as that which was passing through the bar. Since the quasi-inertia of the lighting circuit was very small, it seems quite probable that the whole of this current for the first few thousandths of a second passed through the outer skin of the steel bar. There is thus no difficulty in understanding the origin of the sudden high temperature of the surface which Lord Armstrong perceived, and yet that the whole amount of heat generated was insufficient to heat the bar to any sensible degree. If the dynamo had been doing no work externally at the time of the accident, the time required to get up a strong enough current out of the dynamo to produce much heating effect would have been very much longer than it was.

ON THE RESISTANCE OF HYDROGEN AND OTHER GASES TO THE CURRENT AND TO ELECTRICAL DISCHARGES, AND ON THE HEAT DEVELOPED IN THE SPARK.†

BY E. VILLARI.

An arc-light between carbon points of 1cm. diameter is well known to be shorter in a horizontal than in a vertical direction; and the arc is somewhat longer in a vertical position with an ascending current than with a descending one, doubtless owing to the greater heat of the anode, which must become more strongly heated when it is uppermost.

Arc-lights were formed in glass bulbs which were filled with dry gases. The carbon electrodes were superimposed in a vertical position, and were then drawn apart from each other until the arc-light disappeared.

The arc was found to be far shorter in hydrogen than in carbonic acid, and in the latter, again, shorter than in air; the ratio of the lengths was about 3·9 : 7·4 : 8·5. In nitrogen, with an ascending current, it is about seven times as long as in hydrogen, and with a descending current it is 25·7 times as long. With decrease of pressure the arc lengthens in nitrogen, hydrogen, and coal-gas; in the two latter, however, it never attains the same length as that of the arc in air. With platinum electrodes the lengths of the arcs in carbonic acid, nitrogen, coal-gas, and hydrogen at ordinary pressures were in about the ratio 16 : 19 : 4·6 : 2·8.

The production of heat at the electrodes was determined for various gases with sparks from a Ruhmkorff's inductorium. The electrodes were thermo-elements of iron and German silver. The heating was investigated in two globes filled with various gases, in which the distance between the electrodes was almost identical. The heating of the negative electrode was greater than with the positive; the difference of the heating effect seemed also to be greater in nitrogen than in hydrogen.

A globe filled with hydrogen or with nitrogen was next used, through which the induction-spark was passed, and the strength of the current measured by a well-insulated galvanometer. The induced discharge was more enfeebled by a layer of hydrogen than by an equally thick one of nitrogen. Moreover, equally thick layers of hydrogen and nitrogen enfeebled the discharge as much as columns of water of 99 and 59mm. respectively. In order to diminish the induction-current by the same amount, the length of the spark in hydrogen was 33mm., in nitrogen 48mm., and in carbonic acid greater than 49mm. Hence the resistances were in the order—carbonic acid, nitrogen, hydrogen. The heating of the electrodes increases with the rarefaction.

The spark was then made to pass over the bulb of a mercurial thermometer in various gases. The temperature increased more strongly in nitrogen than in hydrogen both for the induction-spark and for the spark from the battery discharge. The heating with both was much smaller in hydrogen than in nitrogen, so that in passing through hydrogen the discharge has a much smaller electromagnetic and thermal intensity than in passing through nitrogen. By substituting for the spark other resistances the same result was obtained. A layer of nitrogen 47·6mm. in length enfeebles the intensity of the induced current to the same extent as a layer of hydrogen 36·95mm. in length; and a layer of carbonic acid 49mm. in length as much as a spark 33mm. in length with the battery discharge. The negative electrode is almost as strongly heated with the discharge in hydrogen as in nitrogen. With the discharge of the condenser it is more heated in nitrogen.

The spark was finally produced in glass tubes which were surrounded by small calorimeters filled with oil of turpentine. Under similar conditions the spark in hydrogen developed more heat than in nitrogen, which is just the opposite to what occurs in the measurement of temperatures. The same holds also for the discharge of cascade batteries.

* *See* British Association *Report*, Bath, 1888, p. 571; or Vol. III. of Sir W. Thomson's collected Papers, to be published in May.

† From the *Philosophical Magazine*.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

MONDAY, April 14th.

SOCIETY OF ENGINEERS.

7:30 p.m. Ordinary Meeting. Paper to be read: "Weighing Machinery and Automatic Apparatus in connection therewith." By W. H. BROTHERS.

TUESDAY, April 15th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be read: "The Application of Electricity to Welding, Stamping, and other Cognate Purposes." By Sir FREDERICK BRAMWELL, Bart, F.R.S.

WEDNESDAY, April 16th.

ROYAL METEOROLOGICAL SOCIETY.

7 p.m. Ordinary Meeting. Papers to be read: "The Cold Period at the beginning of March, 1890." By CHARLES HARDING, F.R.Met.Soc. "On the Possibility of Forecasting the Weather by means of Monthly Averages." By ALBERT E WATSON, B.A. "Note on the Whirlwind which occurred at Fulford, near York, March 8, 1890." By J. E. CLARKE, B.Sc. "Rainfall of the Globe." By W. B. TRIPP, M. Inst.C.E.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. "Old and New Fashions in Typography." By TALBOT B. REED.

ROYAL MICROSCOPICAL SOCIETY.

8 p.m. Papers to be read: "Freshwater Algæ of North Wales." By W. WEST. "The State in which Water exists in Live Protoplasm." By M. M. HARTOG.

THURSDAY, April 17th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture: "The Heat of the Moon and Stars." By Prof. C. V. BOYS, F.R.S.

FRIDAY, April 18th.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "Welding by Electricity." By Sir FREDERICK BRAMWELL, Bart., F.R.S.

Digitized by Google

The Electrician.

Published every Friday. Price Fourpence; Post Free, Fourpence Halfpenny.
Editorial, Publishing and Printing Offices

SALISBURY COURT, FLEET ST., LONDON, E.C.

Telephone No. 2714. *Telegrams:* "ELECTRICIAN NEWSPAPER, LONDON."

All Communications to be addressed to "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN."

All letters intended for insertion in "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. Subscribers should receive their copies by the first post on Friday morning.*

"THE ELECTRICIAN" *is on sale at the railway bookstalls throughout the United Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices as above.*

SPECIAL NOTICE.

Owing to the increase in the number of pages of "THE ELECTRICIAN," in order to partly cover the increased postage, we have been compelled to revise the rates for Foreign Subscriptions, which are now as follows:—

	3 months.	6 months.	12 months
For Foreign Parts and Colonies:—	s. d.	s. d.	s. d.
Within Postal Union	6 6	12 6	24 0
Aden, Borneo, Ceylon, China, India, Japan, Java Labuan Mozambique, New Caledonia, Persia, Philippine Islands, Siam, Transvaal, and Zanzibar	7 6	14 6	28 0
The rates for the United Kingdom remain as follows:—	5 0	10 0	19 6

TO ADVERTISERS.

"THE ELECTRICIAN" *offers exceptional advantages to Advertisers.* **It has the largest circulation of any English Electrical paper, and circulates all over the World.**

Particulars relating to Advertisements will be promptly forwarded on application to the office.

TRADE ADVERTISEMENTS *intended for the current issue must be handed in not later than First Post on Thursday morning.*

SMALL PREPAID ADVERTISEMENTS *(for Rates see page xv.) are accepted up to 4:30 p.m. on Thursday.*

TECHNICAL PRINTING.

"THE ELECTRICIAN" PRINTING AND PUBLISHING COMPANY (LIMITED) *beg to inform Electricians, Electric Light Engineers, &c., that they make a specialty of Technical Printing, and have a Staff thoroughly acquainted with Electro-Technology. They can, therefore, promise Accuracy and Despatch in the Printing of Electrical Catalogues and Electro-Technical Literature generally.*

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.

Royal 8vo, 5s., postage extra.

Early in each year is issued "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK. *The* DIRECTORY *was established in 1883, and the 1889 Edition consisted of more than 600 pages of printed matter. The names and addresses of all persons engaged in the Electrical Industries may be relied upon as accurate. Useful Tables and Electrical Formulæ, and information specially compiled for this work are given, together with popularly-written Biographical Notices of the leading Electricians, Electrical Engineers, &c., accompanied in many cases by Portraits.*

The issue for 1890, which is still further enlarged and improved (making 850 pages), is NOW READY. Orders should be forwarded at once to the Publishing Offices, Salisbury-court, Fleet-street, London, E.C.

CONTENTS OF THE CURRENT NUMBER.

NOTES 563
Magnetism in Iron and other Metals.—XIII. By Prof. J. A. Ewing, F.R.S. Illustrated. Continued 567
Electric Arc Light Carbons. By O. G. Pritchard. Illustrated. Continued 568
On an Accidental Illustration of the Effective Ohmic Resistance to a Transient Electric Current through an Iron Bar. By Sir William Thomson ... 570
On the Resistance of Hydrogen and other Gases to the Current and to Electrical Discharges, and on the Heat veloped in the Spark. By E. Villari 571
Meetings of Scientific Societies. 571
THE DEVELOPMENT OF ELECTRIC TRACTION 572
OBITUARY—
John George Dunn 573
Reviews 574
On Electric Motors in General Railway Work. By Dr. L. Bell 575
Physical Society—
"On the Shapes of Movable Coils used in Electrical Measuring Instruments." Illustrated 577
The Michales Electric Mining Machine. Illustrated 578
Presidential Address to the Liverpool Physical Society. By Prof. Oliver Lodge, D.Sc., LL.D., F.R.S. 579
Bristol's Portable Electric Lamp. Illustrated 581
Paris Notes 581
CORRESPONDENCE—
Alternating v. Continuous Currents in Relation to the Human Body.—H. Newman Lawrence 581
Electric Light Installations and the Management of Accumulators.—Sir David Salomons 582
Dynamo and Motor Design.—The Writer of the Abstract 582
"The Villari Critical Points of Nickel and Iron.—Herbert Tomlinson 582
More Light on Electricity.—James Johnstone 582
Word-Coining.—O. C. D. Ross 582
"Duriflex Packing." Illus. 583
Trade Notes and Notices 583
PATENT RECORD 583
COMPANIES' MEETINGS, &c.—
The Brighton and Hove Electric Light Company (Limited) 584
New Companies Registered ... 585
City Notes, &c. 585
Companies' Share List 586

"THE ELECTRICAL WORLD" OF NEW YORK.

"THE ELECTRICAL WORLD" OF NEW YORK *can be obtained* "THE ELECTRICIAN" *Office, Salisbury-court, Fleet-street, London, E.C. The Rate of Subscription (payable in advance), is* **£1 1s.** *per annum. Single Copies* **price 6d. each; post free, 8d.**

"ANALES DE LA ELECTRICIDAD" OF BARCELONA.

Published fortnightly. Annual Subscription (Postal Union) Fifteen Pesetas. Single Copies **6d.; post free 7d.** *A Specimen Copy will be forwarded and subscriptions received by* "THE ELECTRICIAN" PRINTING AND PUBLISHING COMPANY, Ltd.

THE DEVELOPMENT OF ELECTRIC TRACTION.

A perusal of some of the more recent American Papers dealing with the subject of electric traction cannot fail to cause English readers to reflect on the unsatisfactory rate of British progress in this direction when compared with the very rapid development on the other side of the Atlantic. The electric railway, although of European birth, seems to have emigrated. Whist in England there are scarcely twenty miles of road operated by electricity, in America we are informed, on Mr. SPRAGUE'S authority, that 1,500 miles are actually constructed or under contract. In this country there are only about ten electric railways to boast of, while in the States there are no less than 130 towns possessing one or more such roads; and these require for their operation 1,700 motor cars and 3,000 motors, with an aggregate capacity of 45,000 horse-power. This remarkable development has, moreover, taken place within the last two or three years; for in 1885 the Americans were no further advanced than ourselves, and possessed no more than three railways, whose aggregate length did not amount to as much as eight miles.

The comparatively slow advance in this country certainly cannot be attributed in any degree to lack of skill among our own electrical engineers. The causes of it are the same as those which have

Digitized by Google

retarded the development of other applications of the electric motor, and are to be sought in the cheapness of coal and in the absence of water-power. Wherever natural sources of power are available, the transmission and distribution of energy by electricity has followed as a matter of course, and the familiarity with electric motors thus brought about has not only been of direct service in increasing the experience of engineers, but also, by familiarising the public with their use, has led them to expect further successful applications. The great difficulty in England has, indeed, been to induce an over-cautious public to believe in their commercial success; and this difficulty would be to a great extent removed if the actual working powers of existing motors were more generally known. It is not an insignificant matter that the two longest electric railways in the United Kingdom, namely, the Portrush Railway, on the SIEMENS' system, and the Bessbrook and Newry line, on the HOPKINSON third-rail system, are each worked by energy obtained from natural water-power, and to the success of the latter may be mainly attributed the fact that the City and Southwark Subway line is to be worked electrically. These instances are, however, quite exceptional. The cheapness of coal, the absence of water power, and the high state of development of other competing industries have, in this country, rendered profitable applications of motors hard to find; and the attention of electrical engineers has been so much concentrated on the commercial development of the dynamo for purposes of electric lighting that the possibilities in store for the electric motor have been somewhat neglected. It is true that motors have been applied with great success in mining operations, where in some cases the electrical plant has been found to be four times as efficient as the previous hauling plant, and several other important and successful uses for motors exist. The general result, nevertheless, has been that, although we have succeeded in manufacturing dynamos quite as good if not better than can be obtained elsewhere, we have nothing in motor development which can in any way compare with that which has taken place in America, where it is asserted that no less than 15,000 motors are at work in connection with as many as 200 different industries.

Returning to the subject of electric traction, it may be some slight consolation for us to remember that, although we can claim to have very few electric railways, every system in use is exemplified in one or other of them, and they are nearly all commercially successful. The Blackpool tramway, worked on the HOLROYD-SMITH system, is one of the comparatively few examples of the practical success of the use of conduits for tractive purposes; and its prosperity should give rise in this country to further development on the same lines. We have also at Barking an example of the use of accumulators for tramway purposes. Hitherto, although we have had numerous collections of statistics to display the advantages of battery traction, the various attempts to prove the practical truth of the statements made cannot be said to have passed much beyond the experimental stage. The future of battery traction is, however, by no means without promise; and when as much attention has been given to accumulators for traction purposes as for electric lighting, horse traction will have to encounter a formidable rival. It is, however, very significant, that while in England we have been content to experiment with single cars drawn along short lines, the Americans have reached the stage, not only of working suburban tramways electrically, but of seriously discussing the possibility of electrically driving express trains along the main lines. As far as mere discussion goes, we can claim to have developed the subject as much, if not more, than the Americans, since the advantages of electrically-driven railways formed the subject of a great deal of thought some years since, and many valuable patents have been granted from time to time to English inventors in this connection, as, indeed, reference to some of our recent issues will show. English development has, however, to a great extent stopped at the Patent Office. The much-talked-of proposal to drive some of the trains on the Metropolitan Railway by electricity has resulted in nothing; and the chief instance we can put forward to show that electric traction is making any headway in this country has reference to the City and Southwark Subway.

In America, however, development has taken place with extraordinary rapidity, and sanguine speculations as to the future of electric locomotion have recently been put forward across the Atlantic by men whose great experience of electric motors is universally acknowledged. Mr. SPRAGUE shows that the amount of copper needed for an electric railway between New York and Philadelphia is comparable with the amount of wire actually in use between Boston and New York for merely telephonic purposes, so that the cost of such a railway need not be unreasonably high on account of conductors. By dividing such a line into sections, with a stationary generating plant attached to each, Mr. SPRAGUE considers it well within the range of possibilities to bring about a 60-mile-per-hour express service of short trains every ten minutes in place of a 40-mile service every hour. Such a change would, as he says, revolutionise travel; and the greater comfort and cleanliness thus introduced, although looked upon as merely sentimental advantages until the new system is shown to be practical, would be acknowledged to be of great importance afterwards. The subject is again referred to by Dr. LOUIS BELL in a Paper on electric motors, which we reproduce in another column. Dr. BELL commences by referring to some valuable American Papers, wherein are recorded data obtained from actual experience with numerous street railways worked electrically, and, after a very practical discussion, he arrives at the conclusion that the diminution of efficiency arising from replacing the locomotive engine by the complex system of dynamo, conductor, and motor will be quite counterbalanced by the possibility of using stationary compound condensing engines of higher mechanical efficiency. An important point referred to is the fact that most of the loss in the electrical system arises from the double system of transformation of dynamo and motor, and not in the line itself; so that if, when the electrical efficiency is 50 per cent., the amount of copper is doubled, the efficiency would be only increased to 60 per cent. The many advantages of electric traction are discussed with especial reference to the working of overhead or underground lines in towns; and the author concludes with stating his firm conviction "that most of us will live to see electricity come into extensive use in general railway work, certainly for special and suburban roads, possibly for long through lines."

OBITUARY.

JOHN GEORGE DUNN.

The following extract from the *Chinese Times* of February 1st gives an interesting account of the labours of the late Mr. J. G. Dunn. To us he was known in 1871 and 1872 as private secretary to Sir John Pender, and he was also well known in the submarine telegraph world, where he had many friends. His unfailing good nature, his wide knowledge, and special aptitude in shipping matters stood him in good stead throughout his life. Although the following obituary notice only speaks of his career in China, Mr. Dunn was well known in London, St. Petersburg, and in Rome; and it is fitting that we should republish this commentary, giving, as it does, the main and closing portion of his not uneventful life. There are but few electricians and naval architects of standing who do not remember Mr. Dunn, and it

Digitized by Google

will be satisfactory to them to know that in his closing days in London he was carefully tended by the officers of the Eastern Extension Company:—

"Endowed by nature with extraordinary nervous energy, brilliant intellectual powers, and a daring spirit, Mr. Dunn exercised his faculties with unceasing diligence, accumulating vast stores of the most varied knowledge which a retentive and accurate memory rendered always available for use, so that he was a kind of walking encyclopædia. And being possessed by, rather than possessing, a special quality of wide-ranging patriotism which seemed to lay hold of all matters of national or international interest with as keen a grasp as if they were intimate personal concerns, he was entirely predisposed to busy himself in public affairs. His strong character gave a tone to his doings which lifted them far above the commonplace, for his standard of honour was high, his devotion to duty passionate and pure, and his fearlessness was that of those whose record can brook the fiercest light. His readiness to sacrifice himself at the call of duty was exhibited even to excess, and to that, indeed, he owed the illness which has carried him to the grave. A night and a day among the ice in an open boat on Taku Bar, with the thermometer below zero, followed by a cart journey to Shanghai in the severe weather of January, 1887, broke up a constitution already worn by painful maladies, and during these three last years the brave heart may be said to have been at hand-grips with death.

Mr. Dunn was best known, perhaps, in connection with ocean telegraphy, of which he was the true pioneer in China. The line which is owned by the Great Northern Telegraph Company was entirely of his conception, and by his sheer energy he carried his scheme so far that he obtained for his somewhat languid backers the actual concession from the Russian Government, which was snatched from him by Court influence and given to the Danes, who acknowledged tardily the wrong that had been done. The first semblance of an agreement with the Chinese Government for the landing of a cable was effected by Mr. Dunn on behalf of the Eastern Extension Company; and any one who is acquainted with the deadness of British representation in China in those days will understand that the dynamic force required to impel it to the needful activity was of no ordinary character. As often happens to leaders of ardent temperament, and as happened to Mr. Dunn on several occasions, he found himself in advance of his supports, obtaining privileges of value which his principals were either too slow to appreciate or were unprepared to take advantage of. The quasi-concession to the English Telegraph Company was allowed to sleep, the Great Northern Company assumed the privilege of laying the cable between Hong Kong and Shanghai, and Mr. Dunn saw himself once more supplanted by the same company which had ousted him at St. Petersburg years before, a disservice which did not slip his tenacious memory.

In process of time the Great Northern Company succeeded in negotiating with the Viceroy Li the concession of a monopoly of laying cables on the Chinese coast, which, if carried into effect, would have entirely superseded the agreement previously made with the English Company. The concession, which was vicious in itself, has remained inoperative, owing very much to the vigorous action in various directions taken by Mr. Dunn, who eventually compelled the Danish to seek an alliance with the English Company; and in concert they effected—but not without enormous difficulties, which were overcome by the *savoir faire* and indefatigable perseverance of Mr. Dunn—amicable arrangements with the Chinese Provincial Governments for the landing of cables and connection with land-lines on the coast, notably at Foochow and Canton. The ultimate agreement for working the various systems of telegraphs, viz., the English and Danish ocean lines and the Russian and Chinese land lines, remains to be settled; but that there is a practicable basis of agreement at all is due mainly to the untiring zeal of Mr. Dunn.

In the politial sphere Mr. Dunn's activity was necessarily more obscure, but its influence was by no means inconsiderable, as he had by his sympathetic manners and really vast information the faculty of gaining the confidence of most of the important individuals with whom he was thrown into contact. In this way he ingratiated himself with the Japanese Minister Iwakura, who drew on Mr. Dunn's exhaustless stores for the knowledge which was so much needed in the construction of the New Japan, on matters political, international, naval, military, and educational. During the crisis of 1874, when Japan had invaded Formosa, Mr. Dunn was made the bearer of messages between the two countries which formed the basis of the solution of the differences effected through the official intervention of the British Minister in Peking. Nor was that the only occasion in which his peculiar abilities were made use of in questions bearing on the relations between China and Japan.

Among Mr. Dunn's many accomplishments his mastery of naval and military science was probably unique for an amateur, and he had the faculty of rapidly assimilating all the current information on these subjects, wherever published. Nothing escaped his keen eye, and he was always posted up on the latest inventions. Nor was his learning superficial, for we have known experts of the highest standing avail themselves of his aid in difficult questions of naval construction, while competent military critics have confessed that his schemes for the establishment, armament, transport, and mobilisation of an army for China were admirably suited to the circumstances of the country, and in advance of rather than behind the times when they were compiled. Mr. Dunn's adroitness and capacity for collecting intelligence on these matters enabled him to render valuable service to his own Government on several occasions when it was important that they should be accurately informed concerning the defensive positions of China and Japan; and to the British Legations in both countries he was at different times a volunteer naval and military attaché, seeking no acknowledgment of his services. Probably this is the first time his name has been mentioned in connection with certain valuable reports which enrich the archives of the two legations. The Papers on defensive organisation which he has supplied to the Chinese Government would furnish the bureau of a Ministry of War.

One of the most important missions with which Mr. Dunn was charged was that from China to the Vatican, in 1886, of which the time has not yet come to give a full account. It was a mission which called for the finest diplomatic tact, and Mr. Dunn's qualifications for the task were special and unique. In its inception the Chinese Government, or, to speak quite correctly, the Empress-Dowager, had one object in view, which they had tried by various means to attain, without success,—the removal of the Pei-t'ang Cathedral from the precincts of the Imperial palace, for which the assent of the Pope had to be obtained. In receiving his instructions, which were conveyed through the Viceroy Li, Mr. Dunn, with the ready resource which seldom failed him in emergencies, saw the opportunity of tacking on another question vastly more important for China than the expropriation of the cathedral, viz., the diplomatic representation of the Holy See in Peking. An invitation for a papal legate was embodied in Mr. Dunn's instructions; but it seems probable that the Chinese themselves never fully comprehended the import of that question, and, while they were looking only for the removal of the cathedral, were amazed at the commotion which was set up in Europe by the mooting of the Christian protectorate which was involved in the nomination of a legate, and which agitated the French Republic to its foundations. No question, indeed, during the present generation has so strained the relations between France and the Vatican; and in defence of her phantom of a protectorate over Chinese Christians the Republic had prompt recourse to her *ultima ratio*, under which the Holy See was compelled for the time to lower its colours."

REVIEWS.

A Treatise on Statics with Applications to Physics. By G. M. Minchin, M.A. Vol. II. Fourth Edition. 1889. (Clarendon Press.)

When the first edition of this work, in one small volume, made its appearance about a dozen years ago, its advent was hailed with delight by teachers and students alike. The reason for this is not far to seek; for, appealing to students with a sound and moderately advanced knowledge of pure mathematics, but who had not attained the heights necessary to enable them to cope with the profound, and, we may add, profoundly difficult, work of Thomson and Tait, it provided them for the first time with an exposition of the subject of statics, or the equilibrium of forces, considered from the physical point of view, and not as a series of exercises in pure mathematics. The author followed from the first the excellent example set by Thomson and Tait in utterly eschewing the consideration of ingenious mathematical problems based upon hypotheses which had no experimental foundation, but had been devised for the most part in order to provide tests of the mathematical ingenuity of candidates at Cambridge examinations. Another very valuable feature, and a novel one in English text-books, was the free use of the graphical methods which are of such fundamental importance to the modern scientific engineer, and which, moreover, are of pre-eminent value in awakening the intelligent interest of the student.

The subject of electrostatics, which does not usually find a place in treatises on statics, had, with great advantage, a short chapter devoted to it in the first edition. In the second and subsequent editions this feature was further developed, and

Digitized by Google

supplemented by the introduction of the subject of stresses and strains, treated in a manner which made this portion of the greatest value to students of electricity, magnetism, or physical optics. The work has now expanded into two octavo volumes, of which the first treats of forces in a plane. The second volume, which is considerably the larger of the two, treats of non-copianar forces, astatic equilibrium, the principle of virtual work applied to any system of bodies, the equilibrium of strings and springs, the theory of attraction, including the theory of potential, and an introduction to spherical harmonics, stresses and strains, and electrostatics.

In the chapter on astatic equilibrium the vector method is employed, which greatly simplifies the treatment. This chapter contains a very clear and simple discussion of the astatic equilibrium of a heavy magnetic body, and a simple construc tion is obtained for the determination of the astatic centre, or point at which a single force will keep the body in astatic equilibrium for displacements in the plane of the magnetic meridian. The chapter on the principle of virtual work contains some valuable observations on Langrange's method of applying the equation of virtual work to continuous material systems, pointing out that in his treatment of certain cases he makes an assumption which is not always justified, and in some instances has led him into error, and may possibly mislead others in applying the method.

The attention of the electrical student should be called to the exposition of the theory of potential, which is brief, but very clear. It includes a discussion of magnetic shells.

The chapter on attraction concludes with an admirable section on Green's theorem, which the author, with justice, characterises as probably the most remarkable and powerful analytical result in the whole range of mathematical physics, and on spherical harmonics, which play so important a part in the mathematical treatment of electrical problems. The exposition of the elements of spherical harmonics is brief, but very clearly put, and the student will be greatly assisted in mastering it by the numerous fully-worked-out examples by which it is followed. This plan of giving a full discussion of carefully selected examples is carried out throughout the work, and is one of its most admirable and helpful features. These worked-out examples are supplemented by many others, which are left for the student to solve for himself.

The chapter on stresses and strains will be found of great assistance in understanding Maxwell's chapter on the mechanical action of two electrical systems. Perhaps the most interesting portion of this chapter on stresses and strains is the section on the "propagation of gravitation," in which the author discusses the celebrated theory given by Maxwell in the chapter referred to, according to which all actions excited between two material systems, according to the law of the inverse square of the distance, can be produced by a distribution of stress over closed surfaces in the medium in which they are immersed.

The chapter on electrostatics, like the rest of the book, is extremely good, and the student will find it of great assistance as an introduction to the study of Maxwell's treatment of the subject.

"L'Année Électrique." By PH. DELAHAYE. Sixth year. (Paris: Baudry et Cie.)

This is a handy little work, in which will be found a brief reference to the most important electrical events and inventions of the past year. It is divided into eleven chapters, dealing respectively with electric lighting, batteries, telegraphy, telephony, atmospheric electricity, medical electricity, electrolysis and electro-metallurgy, electricity applied to railways, electrical distribution and transmission of energy, measuring instruments, and obituary. The volume is, on the whole, well up to date and complete. In Chapter I. we have a description of the Kapp regulating transformer, and in Chapter III. several pages are devoted to Messrs. Wright and Moore's printing telegraph and to Mr. Langdon Davies' phonopore. Tolerably full notices are also to be found of the Webster sewage and the Hermite bleaching processes; of the Leblanc alternate-current motor, Hookham and Shallenberger meters; and to Mr. Shelford Bidwell's interesting researches on the effect of light on the magnetisation of iron.

Almanach-Annuaire de l'Électricité et de l'Electrochimie. Année 1890. (Paris: Firmin Leclerc.)

This is the sixth year of the publication of this useful guide to the electrical trades in France, Belgium, and Switzerland; and, like other Electrical Directories, it bears witness to the continued growth of the industry. The Annuaire is divided into five parts. Part I. contains lists of the members of the chief French electrical societies. Part II. is a directory to the various electrical industries in Paris, which are grouped under about 180 different headings. Part III. is a guide to the electrical industry outside Paris, each department having its separate list. Parts IV. and V. deal with Belgium and Switzerland. The volume seems very complete so far as it relates to Paris, to which nearly 120 pages are devoted; but the information with regard to the whole of the rest of France is contained in one-third of this space. A general alphabetical list of names would be a decided addition to the Annuaire.

ON ELECTRIC MOTORS IN GENERAL RAILWAY WORK.*

BY DR. LOUIS BELL.

The title of this Paper makes it sufficiently evident that I do not intend to indulge in retrospection, except in so far as is necessary for illustration, but shall turn my attention to what is now a probability of the future. The electric motor for street-car service is an accomplished fact, as some hundreds of miles of road in daily operation bear witness. So far as practical success is concerned, the electric railroad is past the experimental stage, and is in the beginning of the commercial era. Many improvements will be made in the future, as they have been in the past, and the direction which some of the improvements have taken suggest and emphasise the probabilities I am going to discuss to-night.

First we must notice that in a large measure the running of single cars has been abandoned except on small roads and heavy grades. A good proportion of electric railroads now regularly use trailers attached to their motor cars, and sometimes trains of two or more. To meet this demand for trains rather than single cars a heavier type of motor has been introduced, and even heavier ones are being projected. A powerful motor car with a couple of trailers attached cannot fail to suggest to the mind a possibility of a still more powerful car at the head of a procession of a couple of baggage cars, two or three day coaches, and as many more sleepers. Enough experiments have already been tried to show that motors nearly or quite as powerful as an ordinary locomotive can be readily made and handled.

Besides knowing the general properties of our present electric railroad, we are now in a position to make a fairly good estimate of its operating expenses. The best discussion of this which has yet appeared is the recent Paper by Mr. O. T. Crosby (*The Electrician*, January 3rd, 1890). His results are worth the careful study of any one interested in the particular subject now before us; and while some of his data were necessarily imperfect, they give a very good general idea of the facts.

Some recent changes in street railway practice may prove suggestive in this connection. First, we must notice the growing use of large and powerful compound-wound generators. An ordinary shunt-wound machine is ill suited to railway service, on account of the very great variations in load, and consequently in voltage; nothing short of compound-winding can or does keep the voltage reasonably constant, and the change is a most decided improvement. Besides this, the voltage in general use has been constantly rising. Less than two years ago, a well-known electrician said that he did not favour the use of more than 400 volts for railway work; there are now many roads on which from 525 to 550 volts at the station is the rule, and pressures as low as 400 volts at the station are quite the exception. This increase in voltage is probably a distinct advantage. In the early days of electric railroading, a couple of years ago, the art of insulating armature and field coils was by no means as highly developed as it is now, and I think we shall soon reach the point where the voltage used for railway work will only be limited by considerations of public safety, and only, therefore, when overhead circuits of bare wire are used. It is gratifying to learn that at the Kansas City Convention it was agreed to adopt, as far as possible, a uniform standard of 500 volts for railway work. We are quite certain now that 500 volts cannot be classified as a dangerous potential—at least, if the current is a continuous one; how much higher than this the limit of safety lies we do not know, though it is quite certainly below 1,000 volts. In-

* Read before the Chicago Electric Club, March 17, 1890.

Digitized by Google

creased voltage means increased efficiency in distribution, and increased efficiency of motors if we can secure the necessary insulation. If we are ever to use powerful motors at a long distance from the generating station, the necessity of high voltage is apparent. The possibility of using high voltages need not be questioned, for in the experiments of Deprez and the more recent experiments at Kriegsteten, potentials from 2,000 to 6,000 volts were quite successfully used. The necessity for high voltage may compel us to use Gramme armatures to secure insulation, but there is no serious obstacle.

Another recent important improvement in motor work is the very general use of carbon brushes, which has facilitated the operation of railway motors in a most remarkable manner.

In looking at the possibility of handling large trains with motors, two questions naturally arise before we can even consider the advisability of attempting it. First, can we readily build a motor to handle railroad trains at railroad speeds? To this question I think we can unhesitatingly answer yes. The experiments of Mr. Daft on the New York elevated road make it very clear that we can build motors large enough to do the work with every hope of success. In those experiments trains of the ordinary weight for elevated work were handled at a speed higher than that required by schedule time. Aside from this, stationary motors of equivalent size are already in use in mining operations. In fact, with large motors, say from 50 to 150 horse-power, we should expect to obtain rather greater efficiency than in the sizes more generally used.

We should expect, theoretically, to obtain a rather higher weight-efficiency with the larger machines. In practice very many manufacturers do not increase the weight-efficiency with the size of the machine. The reason for this I do not know; possibly because a machine of lower weight-efficiency is sometimes cheaper to build. This question aside, there are certain advantages of a practical nature in using these large motors. When a motor becomes too large to be put under an ordinary car body, and a special motor car is constructed to hold it, it works under conditions very much more favourable to smooth and successful running, for it is far less exposed to accident and the continual small troubles arising from dirt than an ordinary street car motor. Then, too, it is possible, not being cramped for space, to arrange the whole motor outfit in such a way that it can be given close and careful attention.

The second question before-mentioned is, can we rely on a motor with anywhere near the same feeling of certainty as on a locomotive? A couple of years ago we should have been compelled to answer this question in the negative, but the great and rapid improvements that have been made in insulation and the various details of construction make one hesitate in giving that answer. We must remember that dynamos of corresponding size are in daily use, and frequently run months, many hours a day, without the necessity of shutting down for any purpose whatever. Given a powerful motor, placed in a motor car where it can have as close attention and as watchful care as any dynamo in a central station receives, and I know of no reason why it should be subject to break-downs or require frequent repairs. To be sure, a motor is subjected to sudden and violent changes of load, but if well made to begin with, and taken good care of, I do not think we should have good reason to fear its being unreliable. The case is not at all comparable with that of ordinary street-car motors, which, besides lacking even a reasonable amount of care, are subject to dirt and dampness to a degree that makes it wonderful that they do not break down oftener. A motor placed in a special motor car, and properly protected, ought to run as successfully as a stationary motor, and thus, unless grossly overloaded, give singularly little trouble.

Putting aside, then, these questions, as those that can be reasonably answered in the affirmative, we come to another vital question: Can the requisite amount of power be transmitted with a tolerable degree of economy to the distances required? This question we are now in a position to answer. It is apparent, I think, at first sight that we cannot expect to distribute over very long distances without a frightful sacrifice of economy. The electromotive forces used are somewhat limited by the possibilities of insulation, and economy of long-distance transmission can only be secured by very high electromotive forces or an enormous expenditure of copper. The immediate solution of this difficulty is to operate the line in sections of reasonable length, and this, of course, can easily be done. This at once raises the question, what is reasonable length? And to answer this question we should have to investigate each special case in detail, for the most economical length of section would involve the relation between the loss of power in transmission over a long distance, and the increased expense of shortened sections, a ratio which evidently involves too many variables to admit of a general valuation.

A question that naturally comes up in this connection is, whether it might not be possible to obtain the best results by means of a constant-current motor and generator? The mechanical difficulties of keeping a long line in order for real series transmission are, I think, too formidable to make this aspect of the question worth discussing, until they shall have been effectively disposed of for short-distance work. If we were only operating, however, one motor per section of line—in other words, transforming the system into a real block system—I am not at all sure but that the constant-current motor could be very successfully used, although its application to railroad work is as yet new. A curious complication is introduced by the fact that if we were to operate a long line of sections, we should find, as the inspection of any time-table will show, that on certain sections no more than one train would be running at one time, while on others several trains would have to be operated simultaneously. On these last sections, larger distributing conductors would be needed, and a little study of the time-table might result in a very considerable saving of copper. As the motor used would be a series motor in any case, I see no objection to working it at a constant-current on one-train sections, if anything were to be saved by it.

I will now consider the power which might be required and the economy that might be obtained in an actual case, taking a single section for an illustration:—

The case which I am going to suppose is a transformation of the Big Four line from Chicago to Cincinnati into an electric road, so far as passenger trains are concerned. The length of the line is a trifle over three hundred miles, and I shall suppose it to be divided into some ten or twelve sections, each with a power station at its middle point. This arrangement of the power stations evidently will secure the greatest average economy. The road is a single-track one, and the hypothetical section which I shall investigate is the section between Kankakee and Sheldon, Indiana, a distance of thirty miles. I take a case of this sort to show what will be the actual power required and the proximate economy in case of an actual railroad running its regular trains on its present schedule time. In looking over any time-table, it will be noticed that any such given section will only require power at certain hours of the day, and a varying amount, according as one or more trains may be operated at the same time. Having worked out the times for supplying power, and the probable amount, I shall then investigate the probable economy of an hypothetical electrical equipment. Looking over the time-table of the Big Four line, between Kankakee and Sheldon, it appears that by changing the time of two local trains from Kankakee to Sheldon, which do not connect with anything, and by changing that time only a few minutes, it would never be necessary to operate more than one train on the section at a time. Making these changes, the hours of supplying power would be 10:25 a.m. to 3:10 p.m., 10:25 to 11:32 p.m., 3:20 to 4:30 a.m. The problem then resolves itself into supplying power enough to operate an ordinary train at the usual speed, and at a maximum distance of 15 miles from the power station.

Let us now suppose the motor to work at 1,500 volts at its terminals at the end of the section. The power required to operate the train would be about 200-250 horse-power at the average speed, consequently the current transmitted over the line would be 100-125 amperes. Of course we might suppose any number of hypothetical line equipments, but I shall confine myself to one in which the amount of copper required will not be specially forbidding. I shall suppose a line wire No. 0, connected at short intervals to a bare trolley wire of silicon bronze or some similar alloy. The conductivity of this system is more than equivalent to a single wire No. 000, on which I should base my calculations. I should suppose track and ground systems to be made in the ordinary way. The length of conductor on each side of the central station would be about 79,000ft., and the fall of potential for 100 amperes over this distance would be a little over 500 volts; the generator, therefore, would have to develop a little over 2,000 volts, and the line efficiency at the terminals of the section would probably be somewhere near 75 per cent. The average line efficiency for the entire section would probably be somewhere near 85 per cent. The total amount of copper required for the section would be about 110,000lb. including insulation, or about 3,600lb. of copper per mile. With, therefore, this amount of copper, which seems not at all excessive, we should have an average line efficiency of about 85 per cent. Now assume a commercial efficiency of the generator of 90 per cent., and assume for the efficiency of the motors and gears 80 per cent., which for motors running at high speed and with infrequent stops does not seem an excessive estimate; the mean commercial efficiency of the combination would be a little above 60 per cent. In other words, taking into account all sources of loss, we should probably have an efficiency of a little over 50 per cent. from the indicated horse-power at the engine to the power supplied at the axles of the car.

Now let us look a little further and see the amount of power which would have to be supplied to the section which we have been considering. Looking over the time-schedule, we see that power is required for almost exactly seven hours, and to supply the 200 horse-power necessary at the train we should have to furnish about 400 indicated horse-power at the power station. We should, therefore, furnish 2,800 horse-power hours to the section under consideration, and we should have the advantage of being able to use

Digitized by Google

compound condensing engines. These engines ought to be able to furnish the indicated horse-power hour on two pounds of coal; the coal required for our supposed section then would be 5,600 pounds for the 24 hours. Banking fires between runs would consume some little coal besides, but, with proper engines and good firing, the 2,800 horse-power hours ought to be furnished on three tons of coal.

We are now in a position to form a tolerably clear idea of the probable cost of equipping such a section as we have been discussing. We shall require for equipment a 400 horse-power compound condensing engine and dynamo to match, then we shall require, as before mentioned, a little less than two tons of copper per mile. In return for the investment in these items, we get an average commercial efficiency of a little over 50 per cent., and the question to be raised is the exceedingly practical one, Will it pay? We gain the advantages of being able to use a very economical engine and of being able to dispense with a certain number of employés. To make these gains we content ourselves with an efficiency of 50 per cent. It is worth noting, too, that the mean efficiency of such a section cannot be raised to a very high figure, for the reason that even with the small amount of copper specified, most of the loss is in the double transformation affected by dynamos and motors, and not in the line. If the amount of copper were doubled, we should still have to be content with a total commercial efficiency of about 60 per cent. In Mr. Sprague's very able Paper (*The Electrician*, March 7, 1890), read before the National Electric Light Association, he has pointed out the economy secured by multiplying power stations and using shorter sections. Without going into detailed estimate, it would seem doubtful whether there would be much practical economy in an extensive system of power stations. The three-wire system suggested by Mr. Sprague in the same Paper is a much more practical way of securing economy, and may come into extensive use. On a double-track road, such as we have in suburban or elevated roads, this three-wire system could be operated to very great advantage.

Let us now look at the locomotive a little for the purpose of seeing whether we are going to gain enough in saving coal and wages to pay for 40 or 50 per cent. energy lost in the various transformations of the electric system. There seems to be a widespread popular delusion to the effect that the locomotive is an exceedingly uneconomical machine. On the contrary, the figures of actual tests show that the locomotive compares very favourably with ordinary non-condensing engines of similar size. Figures obtained with the Strong locomotive show some of the runs as being made on less than four pounds of coal per indicated horse-power, and the average result being most remarkable. Various foreign experiments point in the same direction to show that a well-cared-for locomotive will give the horse-power-hour on 27 to 30 pounds of water. As it is now, then, the locomotive appears to be rather more economical than the average non-condensing single engine, but if the locomotive is ever pushed hard by any other motive power, it will be developed in the direction of compounding. We have already enough tests of compound locomotives to form a pretty distinct idea of the saving that can be effected, and, on the whole, we must conclude that, in the matter of efficiency, the compound locomotive gives about the same results as any other compound non-condensing engine.

It would appear, then, that the saving of fuel effected in the electric system would practically be that due to the difference between condensing and non-condensing engines. The saving in fuel would probably be about one-half. The saving in employés would be comparatively small, as two or three men would be required to operate each power station. The margin of economy, therefore, between an electric system and locomotives appears to be about enough to balance the losses in the transformation in the electric system. This latter, however, has two additional advantages that tend to economy. In the first place, a somewhat cheaper grade of coal can be used with a stationary engine, because better firing is possible. In the second place, an electric locomotive would have a decided advantage in the matter of weight-efficiency, which ensures a slight economy in power. I should say that an electric locomotive of the power we have been considering would weigh from 30 to 50 per cent. less than an ordinary locomotive with its tenders. One instinctively asks if this lighter weight does not mean decreased tractional power? And hence, does it not work to the disadvantage of the electric locomotive? This opens the question of the effect of using the rail return for the current which supplies the power. Most of those who have studied the subject think that the adhesion is somehow greatly increased by the passage of the current from the wheel to the rail. So far as I am aware, there are no experiments, under anything like working conditions, which give us a definite idea of the facts. That the general opinion is well founded I have little doubt, and in looking over some of my note-books I have found some experimental evidence. This was a fact well known, I presume, to others who have experimented on electric cars, that the ratio between the power required to start a car and that required to keep it in motion is quite out of proportion with the results one would expect, judging from dynamometer tests on ordinary street cars. I am of the opinion that the increase in adhesion, even under ordinary working conditions, is very considerable. Where very heavy currents are used, we know from actual experiment that such is the case, as has been shown by Mr. Ries.

And this naturally raises the question as to the possibility of reaching very high speeds by the use of the electric locomotive. Of course, in any case, increased speed means greatly increased power, and the question then becomes one of comparative weight-efficiency and adhesion. This comparison is certainly to the advantage of the electric motor; but we must remember that the limitations upon railway speeds to-day are not those set by mechanical difficulties, but by considerations of safety and economy, and these do not change in any marked degree with a change in the motive power. If it would pay to run railroad trains at an average speed of a mile a minute, it would have been done long ago, and there is no reason to expect that the use of electricity would quicken the running time, unless the public demanded it, and felt quite safe and reassured at the prospect of being hurled through space at the rate of a hundred miles per hour, or thereabouts. If there should be an imperative demand for very high speed, I think one may roughly estimate that the use of electricity would nearly double the speeds now in use; but the question of these very high speeds is purely a question of dollars and cents, for, as a rule, very fast trains are not found to pay particularly well. In the case of a suburban road, the saving in wages would be considerable, since one power station would suffice for the whole system; and the same, of course, is true of any large system operated from a single station.

(*To be continued.*)

THE PHYSICAL SOCIETY.

At the meeting of this Society on March 21st Mr. T. MATHER read a Paper—

"On the Shapes of Movable Coils used in Electrical Measuring Instruments."

In the Paper "On Galvanometers," by Messrs. Ayrton, Sumpner and Mather, read before the Society on January 17, 1890, it was pointed out that the coils of the d'Arsonval galvanometer should be long and narrow, and without an internal core. The author observed that the construction of the coil in Mr. Boys' radiomicrometer showed that he had previously arrived at the same conclusion. His object in the present Paper was to determine the best shape of the coil perpendicular to the axis of rotation. Though he had treated the question with reference to the d'Arsonval instrument, the reasoning would apply generally to other instruments with movable coils.

Suppose the axis of rotation of the coil to be perpendicular to the plane of the paper, and to intersect it at the point O (Fig. 1),

FIG. 1.

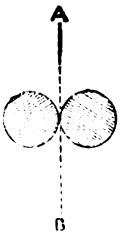


FIG. 2.

and suppose the direction of the magnetic field in which the coil moves to be defined by the line A B. Let P be an element of the section of the coil at a distance, r, from the axis, and θ the angle P O A. Then the deflecting moment excited by unit-length measured perpendicular to the plane of the paper is

$$H C a r \sin\theta,$$

where H is the strength of the field, C the current per unit-area of section, and a the area of the element. The moment of inertia of the element about the axis will be

$$W a r^2,$$

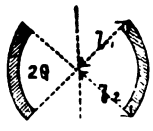
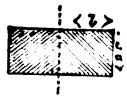
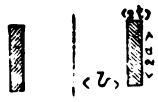
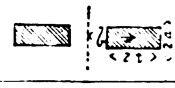
where W is the density, or mass of unit-volume, of the element. For ordinary commercial instruments the conditions to be fulfilled are a moderately short period and a minimum absorption of power. Therefore, since for a constant period the controlling moment at unit-angle must be proportional to the moment of inertia, the

Digitized by Google

problem is to determine the shape of the section so that the ratio of the deflecting moment to the moment of inertia may be a maximum. For the element considered this ratio varies as $\sin\theta / r$; since H, C and a may be considered as constants. Now it may be shown, as in Maxwell's "Electricity and Magnetism," Vol. II., p. 332, that a given length of wire will produce the maximum effect if wound within the surface of revolution formed by the rotation of the curve $p = x_1 \sin\theta$ about the axis, where x_1 is a constant. Thus this curve, which represents a circle tangential to A B at O, is the best form for the section, the complete form of which therefore consists of a pair of circles touching at O, as shewn in Fig. 2.

The section lines of the two circles are drawn in opposite directions to indicate the opposite directions of the currents in the two. The problem might also be treated by finding the shape and position of an area having a given moment of inertia about a point in its plane such that the moment of the area about a co-planar line though the point should be a maximum, viz., taking the point as pole, and the given line as the line of reference, the expression $\iint r^2 \sin\theta \, dr \, d\theta$ has to be made a maximum, subject to the condition $\iint r^3 \, dr \, d\theta = \text{constant}$. The question had previously been solved in this manner by Dr. Sumpner, to whom the author has suggested the problem.

The accompanying table illustrates the improvement obtainable by winding the coils in this manner.

—	Shape of Section.	Deflecting Moment / Moment of Inertia.	Deflecting Moment per unit moment of Inertia.
1		$\frac{4}{3b}$	1·02
2		$\frac{4\sin\theta}{3b\theta}$	·91 ($\theta = 30°$) ·95 ($\theta = 45°$)
3		$\frac{8}{3\pi b}$	·80
4		$\frac{4\sin\theta}{3\theta}\left(\frac{b_1^3 - b_2^3}{b_1^4 - b_2^4}\right)$	·44 $\left\{\begin{matrix}\theta = 19° \\ b_2 = \frac{12}{13} b_1\end{matrix}\right\}$ *
5		$\frac{3b}{2(b^2+a^2)}$	·97 ($2a = b$) ·91 ($4a = b$)
6		$\frac{3}{4b}$	·79
7		$\frac{3b}{t^2+a^2+3b^2}$	·47 $\left\{\begin{matrix}t = \frac{1}{15} b \\ a = \frac{1}{5} b\end{matrix}\right\}$ †
8		$\frac{b}{b^2 + \frac{c^2}{2}}$	·38 ‡ ·40 $\left(c = \frac{1}{11} b\right)$ §
9		$\frac{3b}{t^2+a^2+3b^2}$	·53 || ·49 ¶

* Low-resistance d'Arsonval. † High-resistance d'Arsonval.
‡ Ganz Wattmeter. § Siemens' Dynamometer (60 amperes).
|| Siemens' Dynamometer (500 amperes). ¶ Siemens' Wattmeter.

The numbers in the third column were obtained on the assumption that the coils were long in proportion to their breadth, a condition not often fulfilled; and when this was not the case the numbers would be still lower, since the parts of the coil at right angles to the axis of suspension add to the moment of inertia, but not to the deflecting moment. Taking this into account, a coil of section (1) would be about three times as efficient as one of sections (4), (7), (8), (9). The new coil would be heavier, and therefore require a stronger suspension, but owing to the considerable friction at the mercury cups, this would not seriously diminish the accuracy of the instrument.

The author then justified his assumption that the moment of inertia might be treated as constant by pointing out that whether the current were led into the coil by mercury cups, by wires which also serve as the control, or by flexible wires independent of the control, the control could not be reduced below a certain minimum, independent of the shape of the coil; and the period also being determined by considerations of convenience, the moment of inertia might be taken as constant. In case of a radial field, such as in the new d'Arsonval galvanometer, with a range of 180deg., the coil No. 1 would not be suitable, but one having the shape of No. 4 would be best. The shape No. 1 could not, of course, be imitated exactly in practice, owing to insulation space being required between the two halves, and in the Siemens dynamometer a considerable amount of space would have to be left for the mercury cups; but even in this case a much closer approximation to the best shape than the one ordinarily employed could be used.

DISCUSSION.

In the discussion which followed the reading of the Paper,

Mr. C. V. BOYS observed that although when the current had to be led into or out of the movable coils by means of mercury cups, it was often necessary to make them of shapes very different from that theoretically most advantageous, yet it was a great advantage in designing instruments to know the relative efficiencies of coils of various shapes. He himself had found while working at the radiomicrometer, that No. 1 was the most advantageous shape. He then pointed out that any coil could be transformed into another equivalent to it both dynamically and electrically by increasing or diminishing its length and section, and diminishing or increasing its width, all in the same ratio.

Prof. AYRTON observed that Prof. Perry and himself when first constructing the wattmeters had noticed the disadvantageous shape of the coils employed in the Siemens dynamometer, and had therefore adopted a different arrangement in designing their wattmeters.

THE MICHALES ELECTRIC MINING MACHINE.*

The accompanying cut shows the construction of a very simple and ingenious machine, constructed by the Michales Electric Mining Machine Company, of Pittsburg, Pa., and designed to adapt and utilise the electric current for the laborious portion of miners' work.

The machine is mounted on a two-wheeled truck. It is 9ft. in length, 1½ft. in breadth, 2¾ft. in height, and weighs about 850 pounds. It is supported with sliding axles for the purpose of balancing when a shorter or longer pick, R, is used. It is mounted with a 2 horse-power Tesla motor, A, from which the power is transmitted through a combination of gear wheels, B C E, and shafting, D, to a cam, F, rounding the drill bar, I. Within this cam F, on the drill bar I, is placed a thumb, b, on the end of which is a small trolley wheel to prevent friction as the cam F passes in front of it. By the rotation of this cam F, its inclined surface passes in front of this trolley wheel, forcing it back and up the incline F, drawing with it the drill-bar I, against the tension of a powerful spring K, which encircles it, until the vertical wall of the cam F passes beyond the trolley wheel, when it is automatically released and forced violently forward by the action of the spring K, the trolley wheel returning to the bottom of the incline F. In order to alleviate the shock to which the machine would be subjected in case the pick R should not strike against the coal, there is an extremely powerful spring N interposed between the shoulder M on the drill bar I and the front end of the tube L which surrounds it. The springs K and N, constructed especially for this machine, are of different tension and mathematically correct, and can be changed in a moment as the character of the work requires. The machine strikes 120 blows per minute and with a force of 9,000lb. to the blow.

The Tesla motor, manufactured by the Westinghouse Electric Company, has been adopted for operating the machine. This motor is peculiarly fitted for mine service, owing to its compactness in design and simplicity of construction. The unique and especially valuable feature is that the current in the armature is an induced current. The ends of the armature wires are soldered together, and there is no electrical connection between the armature and the outside circuits. There are no brushes to require adjustment, or to spark or burn out a commutator. The absence of commutator and brushes allows the armature, which is the only moving part of the motor, to be completely inclosed and protected from mechanical injury. No regulator of any kind is used, and the only piece of apparatus in connection with the motor is a simple switch. Owing

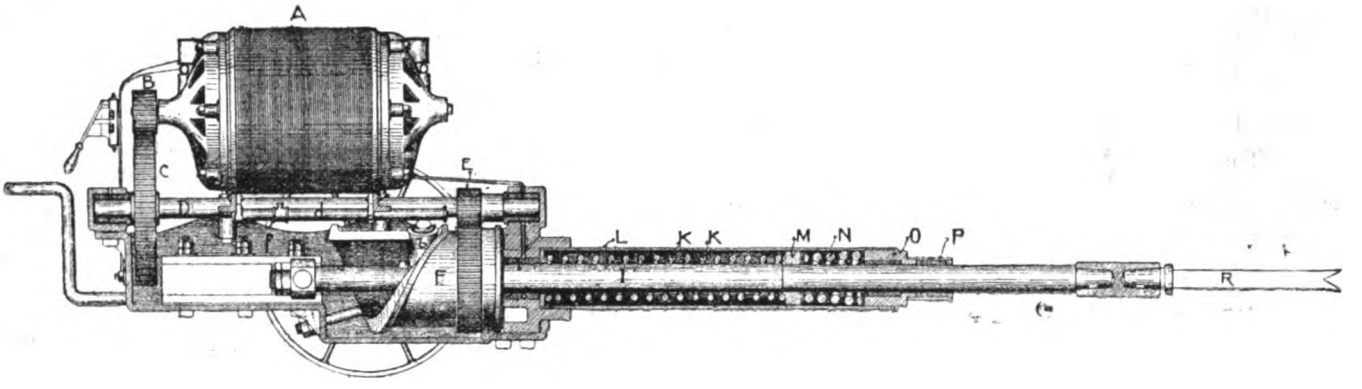
* From the *Electrical World*, March 29, 1890.

Digitized by Google

to the continuity of the circuit and the absence of brushes and bare contacts requiring adjustment or handling, it is perfectly feasible to use an electromotive force higher than could otherwise be conveniently handled. The motor has been operated with a pressure of 250 to 300 volts. It can easily be constructed for use with either a higher or lower pressure, according to the requirements in special cases. The extreme simplicity of the electrical part of this mining machine enables it to be put into the hands of miners who have had no previous experience with electrical machinery.

One very commendable and unique feature of this machine is that at whatever point in the stroke the pick is arrested, it is instantly returned from that point ready for the next blow; and when the blow is delivered, even though it be arrested in its course, instead of the machine pushing itself away from the coal, as one would naturally suppose it would do, it rather inclines to the coal, owing to the momentum of the drill bar. It will not interfere with the working of the machine where it is necessary to post close to the face of the coal.

The machine is light and easy to handle; being composed principally of steel, is very strong and durable, and will stand almost any amount of abuse. It is very simple, beautiful in design, and neatly finished. The method of operating this machine is as follows:—The machine having been placed to the coal, the operator takes his seat behind it, and having perfect control of it, places each blow, as would the hand miner, where it will be most effective, cutting from four to six feet deep. This cut is made on a level with the floor, being of a V shape, eight inches in front and tapering back to two inches in the rear, making an average cut of five inches. When the under cut is made, the operator in like manner can shear the ends. One great advantage of this V-shaped cut is that, when the coal falls it will roll over and out of its original position, where it can be very advantageously loaded. It requires one man and helper to operate the machine.



Michale's Mining Machine. Side view, with one half of the machine proper removed.

The machine has been thoroughly tested in the hardest coal in Western Pennsylvania, and the results have been of a most gratifying nature.

PRESIDENTIAL ADDRESS TO THE LIVERPOOL PHYSICAL SOCIETY.*

BY PROF. OLIVER LODGE, D.SC., LL.D., F.R.S.

We meet here as a working society of members, all alike interested in physical science and willing to study seriously the enormous groups of phenomena which that term covers. Our subject is a most enticing one, but it is alarmingly huge. No man can pretend to be equally familiar with all parts of it, and with all its border sciences. Yet, to be a complete physicist, that is what is demanded. As the German proverb says, "Ein Physiker muss Alles kennen," and the hopeless impossibility of satisfying such a demand ought to brace us to fresh effort rather than to unnerve us with slackened energies. Such a demand, moreover, has the happy equalising effect of the theological doctrine of original sin and free grace: it makes us all alike incompetent and unworthy; and since no man is able to proclaim himself a complete physicist, every man who takes up and works at one corner of it may hope for some result from his labours, if he pursues them in a patient and candid and undogmatic spirit. With those persons—paradoxers, as De Morgan called them—who, on the strength of a few ill-considered notions, propose to reconstruct the universe, and to flout their conceited ignorance in the face of the great searchers after truth of all eras: with them, I was going to say, we have no patience. But patience one does have with them nevertheless, for they are frequently unhappy and misguided men, not without a certain ability, possessors often of a very enviable energy; men who, if rightly self-directed, might have accomplished something, but who, by reason of some trivial crank, continue all their lives to batter themselves fruitlessly against the hard wall of opposing fact, flattering themselves that they are attacking a malicious combination of unprincipled scientists, banded together in league against them.

Such are the men who say that the earth is flat, that electricity and heat are identical, that water is a form of energy, that the circumference of a circle is commensurably related to the diameter, and so on. Men, again, who assert that they have discovered a new force, and that the nature of electricity has revealed itself to them, after reading some three-and-sixpenny text-book on the subject. Such persons should be informed that what they have found in an elementary text-book is but the A B C of the subject, and for them to presume to have a first-hand opinion on it is as absurd as if a person who had read nothing but a few pages of English Grammar, should propound opinions on English literature, and write an essay on the works of (say) Mr. Browning. Not such, however, are the men who ever advance science. The unprofessional workers are patient humble men, who grope their way, occasionally by means of mathematics, more often by means of experiment; searching diligently and recording their results, guided by instinct often more than by knowledge, knowing indeed it may be very little, and making many mistakes, but perseveringly amending their methods and devising fresh ingenuities of attack. To some of these it is occasionally given to discover secrets hidden from the wise and prudent. A trained mechanician, for instance, has immense advantages in the command of tools and weapons of investigation. Such workers have often a deftness of hand, a keenness of eye, and a delicacy of touch, which those who have had more time and opportunity for study have good cause to envy. And their very lack of a wide outlook, by leaving them leisure and will to concentrate attention on one small corner of the field, may result in their detecting treasure unsuspected by the man of broader views. Continually it has to be noticed that the most novel and surprising facts are discovered, not by the man of learning, who is apt to be over-weighted by his stores of information and to move rather cumbrously in unexplored territory, but by the light skirmisher or adventurous explorer, who penetrates with apparently inadequate equipment into wilds and thickets regarded as scarcely penetrable by the more completely panoplied general of modern science.

I will now see what useful suggestions I am able to make concerning fields of work lying open to the explorer at the present time. Needless to say that those I do not see or at the time think of are more numerous by far than those I mention, but, standing up and looking about, I see a number of likely-looking avenues which may lead to something if followed up; all that is needed being a good head, patient labour, and persevering skill to bring facts to light now only dim and unknown. Some of these avenues I will now do my best to point out; and though, no doubt, some are blind alleys if pushed into straight ahead, it is wonderful what side issues and unexpected openings present themselves when once you have set out on a quest. This is the great advantage of a study of nature. You may, by ill-luck, start with erroneous ideas, and may be aiming after something impossible to attain; but if you keep your senses open by the way, the things you will

* Delivered at the Inaugural Meeting held on December 16, 1889. Abstracted from *Research*.

Digitized by Google

unexpectedly hit upon turn out far more interesting and really valuable than the chimera in quest of which you started.

Running over some of these open paths we come across a fruitful field in a study of the effects of light on a great number of things. That light affected chemical combinations has long been known, and it is the foundation of photography, but we now find there is scarcely anything which light does not affect. It affects solenium enormously, bringing down its electrical resistance to half or one-third what it is in the dark: it may affect other bodies in a similar way. It affects metals, charging them electrically in a curious way, especially such metals as zinc. It seems to disintegrate or evaporate surfaces long exposed to it. It affects the electric field, causing a short spark to occur much more easily in ultra-violet light than in the dark. And quite recently, by Mr. Shelford Bidwell, it has been found to affect the magnetism of an iron rod in a sensitive condition. Of none of these phenomena has the investigation more than begun. Then, in the region of photography, there is a good deal to be done not only in understanding the photographic process itself, but in photographing rays hitherto intractable. The photography of ultra-red rays a good way below the visible spectrum is, so far as I know, in the hands of Captain Abney, who discovered how to do it. But others should now take it up and develop it. Celestial photography, with plates sensitive to obscure rays, might reveal a number of unsuspected and invisible semi-cool worlds. The electric spark has lately been a favourite subject for photography, and much good work may be done by obtaining judicious photographs of lightning on fixed and on moving plates. A double-nozzled camera, with two plates, one fixed, the other spinning rapidly on an axis perpendicular to its plane (kept spinning at an approximately slow speed, say by clockwork), so that the same flash is depicted on both plates simultaneously, would give much valuable information. For some flashes a very moderate speed of rotation, or even a waggling camera, suffices, but for others a speed of 30 revolutions a second gives an image apparently the same as if the plate were still. What is known as the Hall effect in various substances has not yet been exhaustively observed or measured. It has not even been observed as yet in insulators, though it ought, one would think, to be there; nor has its connection with the Faraday effect, the rotation of the plane of polarisation of light by magnetism, been at all satisfactorily or finally made out; while its discrimination from, or assimilation to, certain known thermoelectric facts is at present hanging in suspense. Perhaps, however, these matters are rather too complex to be suitable for mention under present circumstances.

A simpler and more qualitative research is the effect of magnetism on a number of things. For instance, on living organisms. A person in a magnetic field is not known to feel anything. Reichenbach thought he had found people who were optically sensitive to a magnet, so that they could see whether an electro-magnet is excited or not. It may be so, but subsequent observation has not gone to confirm it. But, even if all persons are insensitive (by no means a likely conclusion without experimental proof), other animals may not be. Phosphorescent things—a glow-worm, or some of the luminous sea beasts of Dr. Herdman—may be fit subjects for experiment. How, again, does a gymnotus or electric eel behave in a powerful magnetic field? I can imagine a fine field for a physicist to encamp on Puffin Island, under the auspices of the Biological Society, and bully some of the microscopic and other animals with electric and magnetic and optical appliances. Even if they declined to take any notice, the fact ought to be ascertained; but if any of them were properly sensitive, development of the fact might be surprising. Then, again, plants: sensitive and other muscular plants are well known to set up electric currents and to be under electric control; magnetism might be applied to plants also; and about their electric phenomena there is much more to work out. Heaps of experiments on plants and on germinating seeds could be made by an ingenious physical experimenter, and, though they might be more sluggish in their response than animals, some remarkable development might ensue. A change of physical surroundings in the course of a few generations might bring about noteworthy changes of structure. Seeds growing under inverted circumstances as regards light have, I suppose, already been experimented on. I do not know. I am not familiar with the subject, and the biological suggestions I throw out are therefore vague. But this I feel, that so long as the origin of life is wrapped in mystery, experiments on the simplest form of protoplasm—subjecting it to a variety of kinds of circumstances, electrical, magnetic, optical, thermal, mechanical, and chemical—may any day, though not perhaps for a few centuries yet, result in an astounding discovery, which will throw our present idea of evolution into the shade.

A number of experiments and observations can also be made on crystals and crystal formation by those who have suitable opportunities. The accidental formation of twin crystals, and the beautiful optical phenomena which develop themselves at the twinning surface, are matters of quite recent discovery, or, at least, of recent attention. So also is the perfectly astounding fact that a crystal, such as Iceland spar, for instance, can be mechanically twinned or pushed over into its perverted form by the pressure of a knife judiciously applied. Effects of magnetism on chemical action have now been discovered, and it is known that a piece of magnetised iron is less easily attacked by an acid than ordinary iron, provided, at least, the iron is pointed so that its lines of force are very diverging, or its field rapidly varying. But many other facts remain to be ascertained in connection with these subjects. The electrical properties of flame are only partially worked out, and their power of discharging static electrification has had fresh light thrown on it quite lately by some experiments of Worthington. The study of phosphorescent substances is yet in its infancy. Why should not a phosphorescent substance give out a really useful amount of light? What is the process by which the glow-worm maintains so brilliant a speck of illumination?

Many amateurs possess an induction coil, having, indeed, often made it themselves. Approximately the same number of amateurs do not know what to do with it when made. They use it to illuminate vacuum tubes, which they buy at a shop, nicely coloured. Well, don't buy them, but make them, and omit the colours. Read the researches of Mr. Crookes, and other more recent investigations on the subject by Schuster, and Moulton, and E. Wiedemann, and others, and you will find in the electrical phenomena of high vacuum an unlimited field for profitable experiment. More than this: a whole continent of practically unexplored territory has just been opened by the discovery of Hertz that electro-magnetic waves in air can be easily produced and detected. Some may know and some may not know of these brilliant investigations into the propagation of electro-magnetic waves. To those who do not know I can give no idea in the course of this address. I am dealing with them in my evening course throughout next term. But anyone with an induction coil, an empty room, and some bits of metal can repeat many of them. And repetition of known experiments is the natural prelude to the discovery of new ones. The Hertzian receiver is a microscopic spark gap. This serves, but it is by no means necessarily the best, as it is certainly not the most metrical method. Gregory has tried a kind of metallic thermometer with some success. In Germany, I hear a kind of bolometer or wire resistance thermometer has been successfuly used. Quite lately, Fitzgerald writes me that a galvanometer in circuit with a simple wire makes these waves apparent. This will simplify their investigation very much. That is always the way. Once a thing has been done, hundreds of ways of doing it turn up. For instance, the telephone. The transmission of speech by electricity seemed a mighty achievement, and so it was; but now, almost anything will transmit speech—a flower-pot full of cinders has been made to talk. The great electro-magnetic waves excited by any kind of electric discharge are now under easy control, and they can be reflected by mirrors, refracted by prisms, concentrated by lenses. They can be polarised and analysed. Diffraction and interference effect can be detected in them. Everything optical has its counterpart in this new region, for they are to all intent and purposes Light: as Clerk Maxwell predicted nearly a quarter of a century ago, from refined and abstract mathematical investigation.

The whole of this great field now lies open to the explorer, and only a few have entered it. Here and there a mathematician, here and there an experimentalist, is at work upon it, but there is plenty of room, and every fact is of interest. These electric waves have been obtained as long as 2,000 miles and as short as a foot; they can easily be lengthened, they cannot so easily be shortened. If shortened to the 10,000th of an inch they would affect the retina and be visible. At present they belong to the region of the infra-red. Whether they affect the human frame at all is unknown. Apparently they do not, but further experience may show that they do. Here also is a scope for observation. This is a good era for the formation of a Physical Society. That there is no time like the present is true, and true always, but it has been doubly true in science during this nineteenth century. Abused we have been; much of our work has been divorced from art and culture, and some of our works are hideous. The foghorns, with which we shall shortly frighten in the new year, are unspeakable; but, for better or worse, the nineteenth century has been the century of science. Never has there been such an increase in knowledge in material achievement; never have so many secrets of nature been unveiled. We inherit the fruits of all this labour, we live encompassed by it—by the evil as well as the good—the smoke-canopied, overcrowded, and squalid towns, as well as the bright and beautiful ideas which this century is responsible for; and it remains for us to enter the twentieth century not abandoning the good but doing our best to remedy some of the evil, and to hand on the at present rather smoky torch of science burning the clearer and the brighter for our life and work.

BOOKS, &c., RECEIVED.

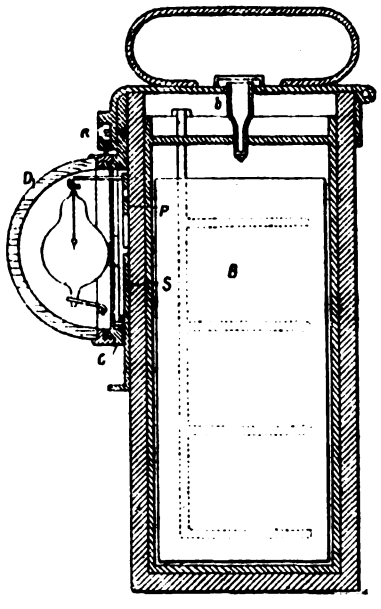
"Force as an Entity." By Lieut.-Col. W. Sedgwick, R.E. (London: Sampson Low, Marston, Searle and Rivington.)

"Proceedings of the Academy of Natural Sciences of Philadelphia." Part III. October-December 1889.

Digitized by Google

BRISTÖL'S PORTABLE ELECTRIC LAMP.

In the figure below we illustrate a neatly arranged portable electric lamp devised by Mr. L. Bristöl. The lamp is particularly applicable for use in dangerous situations, such, for example, as coal mines, powder mills and magazines, chemical laboratories, &c. The current is provided by an accumulator inclosed within a polished wood box, on the face of which, for the above purposes, the lamp is fixed within a strong glass dome, D, and backed by a reflector. The box has a metal lid with a projecting lug, which covers one of the charging terminals, so that when the lid is closed the battery cannot be short-circuited. The lid also carries a lock, *a*, by which it can be secured; a pin on this lock fixes the glass dome against being unscrewed. The holders of the glow lamp are attached the one to the positive terminal P of the battery, and the other to an independent plate, between which and the negative terminal of the battery circuit is made and broken by the spring sliding switch S passing through a groove behind the plate C.



The battery plates B are of special construction, designed to give them such a degree of self-cohesiveness and rigidity that no additional metallic support is required. There is mixed with the active material a suitable proportion of fibrous substance, and the whole is made into a paste. This is cast in moulds, a conductor being inserted in each plate to aid the flow of the current. The plates are then gently pressed and dried. A hollow plug, *b*, is provided for the escape of the gas given off during charging.

The following are some data with regard to these lamps.

Candle-power.	Hours of Light.	Weight. lb. oz.	Height. in.
1½	10	3 6	5½
1½	15	5 4	6½
1	5	1 12	4

PARIS NOTES.

(FROM OUR OWN CORRESPONDENT.)

April 9, 1890.

The Exhibition of the Société de Physique took place on Tuesday and Wednesday last in the rooms of the Société d'Encouragement. Amongst the new apparatus I noticed an absolute condenser, with guard-ring, by M. P. Curie. This condenser consists of two glass plates, very carefully faced, one side of each plate being silvered. On one of the silvered faces a circle, having a diameter of 6 centimetres, is traced with the compass, the line traced being $\frac{1}{15}$ of a millimetre thick; and in this way a disc of known geometrical dimensions is insulated from the rest of the plate, which constitutes the guard-ring. A little hole pierced in the centre of the circle allows a wire to be connected to the terminals of the apparatus. The other side of the condenser is formed by the second silvered glass plate. Upon the lower plate are three little glass supports, the thickness of which is carefully determined by a spherometer, and on the top of these glass supports the first plate rests with its silvered face underneath. We thus have an absolute condenser, whose capacity is determined from its geometrical dimensions. Amongst the other new apparatus, I noticed a resistance-box for commercial purposes, in which the arms of the bridge can be quickly altered by turning a handle, and a Thomson bridge by which one can easily measure $\frac{1}{10000}$ ohm in testing the conductivity of copper wires. There was also to be seen one of M. le Châtelier's pyrometers, consisting of a long iron tube enclosing a thermo-electric platinum—platinum-rhodium couple, contained in a tube composed oi a refractory earth; the apparatus also comprised a Deprez-d'Arsonval galvanometer, the suspending wires of which can be rapidly changed in order to vary its sensibility. These three instruments were shown by M. J. Carpentier. M. E. Ducretet showed a pretty little instrument for repeating the experiments of Elihu Thomson. The apparatus consisted of a balance, one pan of which was replaced by a coil of wire connected to a small lamp, and in the centre of this there was a fixed coil connected to an alternate-current machine. When the primary circuit is closed the lamp is lighted, and the equilibrium of the balance is disturbed. To restore equilibrium it is necessary to take weights out of the opposite pan. M. Ducretet also showed a large Wimshurst machine, having 12 plates 75 centimetres in diameter. Besides these new instruments there were a large number which, although not absolutely novel, were nevertheless of some interest. Amongst these I may mention a Deprez-d'Arsonval ballistic galvanometer, which comes to rest the moment it is short-circuited; a megohm divided into ten resistances of 100,000 ohms; a large-deflection (180 deg.) D'Arsonval galvanometer, the scale of which is graduated in milliamperes for electro-therapeutic purposes; some remarkably fine photographs of lightning flashes, by General Sébert; a Curie-Blondlot astatic electrometer; and some Reynard batteries. Considering the short time which has elapsed since the closing of the Universal Exhibition, the show of new apparatus was remarkable.

At the last meeting of the Société Internationale des Électriciens M. Hospitalier raised some objections to the methods of measuring used at the Laboratoire Central d'Électricité, and described at a previous meeting by M. de Nerville. M. Hospitalier objected principally to the alternate-current measurements, which are effected by means of an electro-dynamometer and an electrometer as if there were no difference of phase between the current and E.M.F. curves. M. Hospitalier further urged that the specific resistance of wires sent to be tested should always be given, and not their conductivity; since the conductivity of a wire is very different according as it is compared with that of another pure (Matthiessen) copper wire of the same volume or of the same mass; moreover, as he remarked, copper may now be obtained by the Elmore process and by other means with a conductivity of 110 per cent. M. de Nerville quite agreed with M. Hospitalier, but stated that he was obliged to conform to the regulations; however, whenever possible, he would state the results in specific resistances. At the same meeting M. Minet gave a detailed description of his process of obtaining aluminium direct by the electrolysis of fused fluoride of aluminium, and showed some fine specimens of pure aluminium so obtained.

The Gare de l'Est, with the exception of a few offices, is now lighted throughout by electricity. The installation comprises 158 Cance arc lamps and 1,100 15 candle-power incandescents. The three-wire system is employed, the dynamos being mounted on the same bed-plate. The Cance lamps are run off a 65-volt circuit.

CORRESPONDENCE.

ALTERNATING v. CONTINUOUS CURRENTS IN RELATION TO THE HUMAN BODY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Please allow me, for my colleague, Dr. Harries, and myself, to reply to the letter of Prof. Forbes, which you published last week.

That there is truth in the statement that the alternating currents from a dynamo differ from those produced by an induction coil, it would be folly to deny; but the extent of that difference, and its *effect upon the human body*, is another matter.

Unfortunately for his case, Prof. Forbes proves too much. He writes:—"The instrument employed measures the *effective* current." . . . "The discomfort measures the *maximum* value of the current;" and further, "Thus the current which caused discomfort was probably *20 to 50 times* the current measured."

If these statements be true, taking his lowest estimate of maximum current, and, therefore, according to him, of *discomfort*, the alternating current which in our experiments produced discomfort was $1{\cdot}7 \times 20 = 34$ *milliamperes*. On the other

Digitized by Google

hand, Prof. Forbes appears to accept our discomfort figure for continuous current, viz., *10 milliamperes*; but the Professor himself stated at the meeting that he *knew* he could not bear nearly as much alternating as continuous current; and several other speakers confirmed this.

As shown above, his letter attempts to prove that it takes *more than three times as much alternating current as continuous to cause discomfort.* In the days of Euclid this would have been called a *reductio ad absurdum*; but in the present day we need only adopt Prof. Forbes's own phraseology, and term *his* error a "fallacy."

In considering the effect upon the body of possible difference between maximum and effective alternating currents we have to take into account potential counteracting effects of increased rates of alternation. Our experience so far is that the slower the rate of alternation the greater the discomfort for the same current strength. Our Paper dealt with a higher rate of alternation than that commonly in use in light circuits. It is therefore highly probable that the increased discomfort which would be produced by the slower alternations of a dynamo circuit would more than counterbalance the possible difference between effective and maximum current due to the use of an induction coil of much more rapid alternation.

Electricians generally show too marked a tendency to look upon the human body as an inanimate conductor, and to apply to it the same laws. I need hardly reiterate what Dr. Harries insisted upon in his reply at the meeting, that the physiological conditions controlling the resistance of the skin make all the difference in the results of contact.

Our Paper deals exclusively—as we mentioned therein—with phenomena *after* contact, and deliberately excludes from consideration factors involved in bringing about that contact.

We desire to emphasise the difference between *resistance* and *sensation*, and trust that in future this important point will not be lost sight of.

As indicated at the meeting, we have further investigations in progress, and therefore forbear entering now more fully into the points raised.—Yours, &c., H. Newman Lawrence.

The Institute of Medical Electricity,
24A, Regent-street, S.W.

ELECTRIC LIGHT INSTALLATIONS AND THE MANAGEMENT OF ACCUMULATORS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: May I be permitted to say a few words bearing upon your friendly criticism of my little book?

The errors you point out are mainly due to general language; but in another edition I will be more explicit. The B. T. unit given as 1,000 watts, instead of 1,000 watt-hours, is evidently an oversight, as are also a few more similar errors here and there in the book, many being the fault of the printers.

One serious mistake exists, but it was discovered by me when too late. The notes upon the ohm-meter were dictated when describing the watt-meter, hence this instrument is wrongly described.

In the sixth edition these faults will be corrected, and many new points added, including a full description, with plates, of Messrs. Goolden's testing apparatus—whose permission has been asked and kindly given; also the practical way to make and insulate joints, at the suggestion of Sir Richard Webster, who considers much ignorance exists on this head. I may say that when the fifth edition was published Messrs. Goolden's tester was not made, so I gave the methods of testing followed by the London Electric Supply Corporation.—Yours, &c.,

49, Grosvenor-street, W., April, 1890. David Salomons.

DYNAMO AND MOTOR DESIGN.

TO THE EDITOR OF THE ELECTRICIAN.

Sir,—In your issue of the 4th inst. a letter appears under the above heading from Mr. W. B. Sayers, in which he complains that the "authorised abstract" of his remarks is "incomplete and misleading." Perhaps you will allow the writer of the abstract to express his great regret that cause for dissatisfaction should have arisen, and to add a few words of explanation. First, as regards "incompleteness." This I admit, for all abstracts are necessarily incomplete.

Next, as to being "misleading," I am willing to admit that the abstract may not express exactly what he intended to convey; but I think Mr. Sayers has himself to blame for not having made his meaning sufficiently clear. This opinion is supported by the fact that he has found it necessary to re-write his remarks before they are printed in the "Journal." He has also thought it desirable to add an "explanatory note" to his contribution, in which he puts his meaning much more clearly than it is given in the verbatim report of what he said.

In this note he also says, "the explanation given by Mr. Swinburne in his reply to my remarks related only to the action which takes place *when the brushes are in the non-sparking position*, and agrees precisely with my statement of the case." This shows that even Mr. Swinburne had not properly understood the "true purport" of what Mr. Sayers said, otherwise he would not have given as his own an explanation which Mr. Sayers had propounded a week previously.

I take this opportunity of pointing out some typographical errors in the abstract of the discussion, as printed in your journal.

Page 528, column 1, line 47, *for* "non-resistance" *read* "non-existence."

Page 528, column 1, line 9 from bottom, *for* "bands" *read* "hubs."

Page 529, column 1, line 5, *for* $\frac{Z\,d}{Z\,\delta}$ *read* $\frac{Z\,d}{2\,\delta}$.

—Yours, &c., The Writer of the Abstract.

THE VILLARI CRITICAL POINTS OF NICKEL AND IRON.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your issue of last week there are two corrections in the report of my Paper on the above subject which I will ask you to be so good as to make: (1), the diameter of the nickel wire used was 0·8 m.m., not 8 m.m.; (2), Mr. Shelford Bidwell pointed out at the end of the reading of the Paper that I had not quite understood some remarks of his respecting the conclusions of Prof. J. J. Thomson. Prof. Thomson did not conclude that a Villari critical point for nickel *could* not exist, but only indicated the *probability* of its non-existence.—Yours, &c., Herbert Tomlinson.

36, Burghley-road, Highgate-road, N.W.

MORE LIGHT ON ELECTRICITY.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I have just completed experiments which prove that a surcharge of electricity, on passing though the glass of a Leyden-jar by conduction, alters the attraction of cohesion of the glass; so that when the jar is fully surcharged, the attraction of cohesion of the glass is then five hundred and fifty times greater than it was before the surcharging commenced.

I also find that the specific increase of the attraction of cohesion caused by a surcharge of electricity varies according to the nature of the substance operated on, and hence there is now a door opened for our understanding the Peltier effect and other electrical phenomena which have hitherto been inexplicable.—Yours, &c., James Johnstone.

8, Murchiston Park, Edinburgh, April 2, 1890.

WORD-COINING.

TO THE EDITOR OF THE ELECTRICIAN.

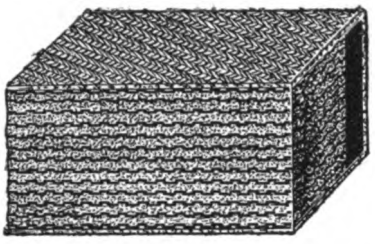
Sir: Could there be a more appropriate word to indicate travelling by electric power, or one which more thoroughly meets Lord Bury's excellent suggestion, than to *Faradate*? which in French becomes Farader, in Italian and Spanish Faradare and Faradear, and in German Faradiren.—Yours, &c.,

April 10th. O. C. D. Ross.

Digitized by Google

"DURIFLEX" PACKING.

Messrs. David Moseley and Sons, of Manchester, have introduced a new engine packing, to which they have applied the trade mark "Duriflex." The object of the manufacturers has been to combine the durability of a metallic with the flexibility of a fibrous packing. "Duriflex" packing is especially applicable where long



runs are a necessity, and for use in high-pressure engines. The packing is constructed in a peculiar manner from wire and a fibrous material such as asbestos or cotton, and from the nature of its construction it follows that it must possess the qualities of durability and flexibility in a high degree. It may be constructed in any form and with or without indiarubber cores; but the ordinary forms represented in the engravings are generally used. In the engravings the wire gauze is indicated by

Round core.

Round rope.

the thicker black lines. This is prepared before insertion in the packing by cutting or corrugating it diagonally and by placing it between the layers of fibrous material with the cuts or corrugations diagonally arranged. By this means the rigidity of the wire gauze is entirely destroyed, and the packing has as great a flexibility as similar packing made entirely of fibrous materials.

TRADE NOTES AND NOTICES.

THE UNIVERSAL ELECTRIC TELEPHONES.—We are in receipt of printed particulars of the Universal Telephone, manufactured by the Universal Telephone Company, who have recently taken premises at 11, Queen Victoria-street, London, E.C. Illustrations are given of several patterns, including the pedestal telephone, the pocket telephone, the domestic telephone, and a telephone for office and general use. We are informed that a large number of these telephones are already in use, and the prices quoted for complete sets are very reasonable. The Company are prepared to undertake the erection of telephone lines, and the supply of all descriptions of telephonic apparatus.

WENHAM COMPANY (LIMITED).—This Company announce that they have added to their business in gas lighting and ventilation an electrical department, under the supervision of competent engineers, and are prepared to undertake all kinds of lighting and engineering work. The Company also notify that Madame Adelina Patti's private theatre and winter garden at Craig-y-nos Castle are being lighted with the electric light, the whole of the work being carried out by the Wenham Company's staff.

ZÜRCHER TELEPHONGESELLSCHAFT.—We are informed that Herren Dr. Emil Blattner and Giovanni Mariotti have become associated with the directorate of this Company.

POSTAL TELEGRAPH AND CABLE COMPANY.—This Company has voted to increase the capital stock from £1,000,000 to £2,000,000, in order to pay Mr. J. W. Mackay for properties owned by him and worked by the Company.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

March 14, 1890.

4,000. H. PIEPER, FILS. London. Improvements in electric regulators.

4,004. H. T. BARNETT. London. Electric excitation of vacuum tubes or other electric discharge paths and condensers in connection therewith.

4,011. F. H. BERRY. London. An improved electrical apparatus for periodically ringing bells, or sounding alarms or signals and registering the same.

4,025. A. A. GOLDSTON, London. Improvements relating to electric incandescent lamps.

March 15, 1890.

4,053. B. M. DRAKE and J. M. GORHAM. London. Improvements in safety devices for high-pressure electrical currents and indicating apparatus in connection with same.

4,086. C. J. BARLEY and H. STEVENSON. London. Improved means or devices for coupling and insulating the shafts of dynamo machines or for other purposes where parts are required to be connected together and insulated from each other.

March 17, 1890.

4,103. J. CAMPBELL. Glasgow. Improvements in electric arc lamps.

4,116. F. J. YOUNG. London. Improvements in magneto call-bell generators.

4,125. E. BERG. Berlin, Germany. A new and improved electric bell.

March 18, 1890.

4,189. F. SUTER. London. The ball-socket switch for electric lighting.

4,191. T. D. FARRALL. London. Improvements in method and mechanism for generating heat, steam, and light by electricity.

4,220. H. C. L. HOLDEN. Woolwich. Improvements in switches for operating and closing electric circuits.

4,231. W. E. GRAY. London. Improvements in the construction of arc lamps.

4,232. W. E. GRAY. London. An improved construction of incandescent electric lamp.

4,235. J. P. REES. London. Improvements relating to filaments for electric lamps for signalling and other purposes.

4,242. A. SIEMENS. London. An improvement in electric railway signals.

4,260. W. P. THOMPSON. Liverpool. Improvements in or appertaining to electrical distribution (Charles Griffith Young, United States).

March 19, 1890.

4,275. J. A. KINGDON. London. Improvements in electrical switches.

March 20, 1890.

4,337. R. BOLTON. London. Improvements in electrical, steam, or other power or hand-cranes or other apparatus for raising and lowering.

4,350. H. T. BARNETT. London. Improvements in apparatus for the closing and opening of electric circuits.

4,366. T. H. PARKER. London. Improvements in electrical thermometers or electrical instruments sensitised by heat for use in electrical meters and other electrical apparatus.

4,405. W. B. SAYERS. Putney. Improvements in armatures for dynamo-electric machines and motors.

March 21, 1890.

4,407. J. B. MCGREW. Glasgow. Improvements in electric railways.

March 22, 1890.

4,533. H. H. LAKE. London. Improvements relating to safety devices for electric circuits (The Thomson-Houston International Electric Company, United States).

March 24, 1890.

4,447. J. WILKINSON. Croft, via Darlington. Conducting telegraph, telephone, and other wires for electric lighting, &c., also pipes, tubes, &c., by means of oblong, square, or other suitably shaped blocks constructed in two halves, and having recesses, grooves, or perforations running longitudinally through them into which the wires, tubes, &c. are to be laid. These blocks are adapted and constructed to take the place of the curb stones, and may be laid in crossings or other parts of roadways or other thoroughfares where they might be required.

4,557. F. V. ANDERSEN and J. O. GIRDLESTONE. Catford, Kent. Improvements in field magnets and supporting frames for dynamo electric machines.

March 25, 1890.

4,605. A. A. C. SWINTON. London. Improvements in electric switches.

4,648. P. F. DEGN. London. Improvements in the construction of dynamo-electric machines.

4,650. H. B. PALMER. London. Improvements in means or apparatus for producing periodical or intermittent motion by electricity.

Digitized by Google

4,660. H. R. Butterfield and W. Mitchell. London. Improvements in devices for heating and cooking by means of electricity, including electric flat irons and other articles.

4,670. O. Imray. London. Electrical heating devices for forging and analogous machines (John Ingersall Gilbert, United States).

4,700. A. W. Isenthall. London. Improvements in or connected with arc lamps.

March 26, 1890.

4,745. A. Essinger and T. P. C. Crampton. London. Improvements in apparatus for applying or directing electric currents from dynamo machines or like generators of electricity.

4,761. L. C. H. Mensing. London. Producing force or power by explosions of water or other liquid electrically.

4,767. J. V. Sherrin. London. Improvements in electro-motors and dynamos.

March 27, 1890.

4,788. W. Brown. Highgate. Electric advertising figures and models.

4,791. W. H. Douglas. Birmingham. An improved instrument for measuring electrical currents.

4,821. E. F. A. Obach. London. An improvement in insulated electric conductors.

4,824. J. Nebel. London. Improvements in armatures for dynamo-electric machines.

March 28, 1890.

4,846. W. Andrews. Nottingham. Multiplying the illuminating powers of electric lights.

4,858. G. Kapp. Manchester. Improvements in multipolar dynamo-electric machines.

March 29, 1890.

4,943. W. Balch and S. S. Bromhead. London. Improvements in batteries for electrical purposes.

4,949. L. Weigert. London. An improved electrolytic solution for galvanic batteries.

4,952. A. N. Contarini. London. Improvements in electric arc lamps.

March 31, 1890.

4,972. R. Kennedy. Kilmarnock. Improvements in arc lamps.

4,973. R. Kennedy. Kilmarnock. Improvements in dynamo-electric machinery.

4,974. R. Kennedy. Kilmarnock. Improvements in electric meters.

4,984. J. Robinson. London. Improvements in electric telegraph apparatus to transmit visible pointer indications corresponding to the movement of a transmitting handle.

4,991. A. Gay and R. Hammond. London. Improvements in electric arc lamps.

4,992. A. Gay and R Hammond. London. Improvements in electric recording apparatus.

4,993. A. Gay and R. Hammond. London. Improvements in electric heating apparatus.

4,994. W. Sinnock. Peckham. An improved arrangement of apparatus for obtaining currents of electricity.

4,998. H. G. Nichols. Bromsgrove, Brentwood, Essex. Improvements in the manufacture of illuminants for electric lamps.

5,008. E. F. Furtado. London. Improvements in electro-telephonic apparatus.

5,016. C. P. Bary. London. Improvements in reversible machines suited for alternating electric currents.

5,023. G. F. Redfern. Finsbury. Improvements in electricity meters (Antonio Fergès, Spain).

SPECIFICATIONS PUBLISHED.

1889.

5,676. Reid and Kean. Electric bells. (Price 8d.)

5,768. Garland. Wooden casings for electrical conductors. (Price 6d.)

7,023. Snowdon. Electric meters. (Price 1s. 1d.)

7,108. Drake and Gorham. Safety devices for high voltage circuits. (Price 8d.)

7,275. De Ferranti. Arc lamps. (Price 8d.)

7,428. Pollak. Electric accumulators. (Price 8d.)

9,537. Timmis. Electric lamps. (Price 6d.)

16,374. Serrâillier and Armstrong. Electric lamps. (Price 6d.)

17,088. Irish. Operating mechanical devices electrically. (Price 1s. 1d.)

20,217. Marx. Galvanic batteries. (Price 4d.)

20,400. Murday. Recording indicators by electricity. (Price 8d.)

20,911. Woolf. Storage batteries. (Price 8d.)

20,971. Imray (Electric Exercising Machine Company). Electric exercising machine. (Price 8d.)

COMPANIES' MEETINGS.

The Brighton and Hove Electric Light Company (Limited).

The report of the Directors of this Company for the year ending December 31st says:—The capital account has been augmented by the sum of £3,860, which has enabled the Company to increase the capacity and efficiency of its plant and to re-arrange and insulate the greater part of the overhead circuits in accordance with the new regulations of the Board of Trade. The profit and loss account, after writing off an ample sum for depreciation of plant (which has, however, been kept in thorough repair out of revenue), shows a balance of profit for the year of £529. 10s. 10d., which, with the balance brought forward from last year's accounts, makes the sum to the credit of profit and loss account £557. 19s. 8d.; but in view of the lawsuit of "Garman v. the Company," the Directors recommend that no dividend be declared in respect of the profits of the past year. It will be noticed that there is a falling off in the profits, which is due to three causes:—

(*a*.) The loss incurred owing to the reduction of price from 1s. to 10d. per unit.

(*b*.) The heavy extra cost of running the machinery night and day during the first half-year.

(*c*.) The great advance in the price of coal, amounting to 7s. per ton.

The Directors confidently look forward in the coming year to the business of the Company at least yielding the former 5 per cent. dividend. The Directors greatly regret that, in consequence of the opposition of the Corporation of Brighton and of the Hove Commissioners, they have been disappointed in their efforts to obtain a Provisional Order under the Electric Lighting Acts, 1882 and 1888. They trust, however, that the Corporation's sense of honour will soon modify this opposition, and that this Company, which is quite willing to submit to any fair terms to be imposed by the Town Council, will not be subjected (after building up the business during the past seven years) to what would practically amount to an act of confiscation and ruin of the local business. The Directors hear that there is a growing feeling among the ratepayers against the town undertaking the business of supplying light to the wealthy and large industrial institutions in the borough, as the rates and the risks will fall upon all alike. Moreover, it is felt that at this stage of the electric light supply, the business has hardly passed out of the speculative category; and that a Cor-

PATENT
SILICIUM BRONZE AND SILICIUM COPPER WIRE.
The best for overhead Telephone and Telegraph Lines,
AND ALL ELECTRICAL PURPOSES.
Hard Drawn High Conductivity Copper Wire.
ROLLED AND DRAWN
PHOSPHOR BRONZE.
PHOSPHOR BRONZE
BEARINGS, BUSHES,
AND OTHER PARTS OF
ELECTRICAL MACHINERY.
SOLE PROPRIETORS of the British, Indian and Colonial Patents,
THE PHOSPHOR BRONZE COMPANY (Limited),
87, Sumner Street, Southwark, London, S.E.
WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

Digitized by Google

poration can never work a business of this kind so economically as a Company like this, with its long experienced and skilled engineers and officials, and thorough acquaintance with the cheapest markets for plant and materials, and that the Corporation will be sure to "burn their fingers," and regret their action sooner or later. It will be remembered that in their last report the Directors advised the shareholders that this Provisional Order was being applied for at the special invitation of the Board of Trade; and at the local inquiry, conducted by Major Marindin, which was held in Brighton in April last, the Directors were confident that they had gained their point, but strong representations being made by the Corporation of Brighton of their intention to undertake electric lighting works themselves, the Board of Trade refused to sanction the Order last Session. Application is, however, being again made this Session, and the Company are confident of eventually either obtaining a Provisional Order or coming to satisfactory terms with the Corporation. If the Corporation carry out their plan of laying opposition works to the Company, the Directors are confident that, though this may prevent an immediate extension of the works, it will not materially injure the Company's present business, as their customers will still obtain their electric lighting supply from the Company; and whatever action the Corporation may take, it will not prevent the Company using and extending its present overhead circuit. Of course the Directors repeat the assurance, which they have from time to time given to the shareholders, that their desire is to lay the wires underground, but, until that is sanctioned by the Provisional Order consented to by the Brighton Corporation, they are compelled to continue their business by means of the overhead circuit. The Company has completed the alterations referred to in their last report, and at the present time the whole of the Company's supply is on the most modern system known, namely, the Converter System, by means of which the heavy waste connected with the use of accumulators is avoided, as well as the heavy cost in mains. The exact nature of the improvement in the Company's business may be seen by the following statements:—

Lamps supplied from the Company's mains on—

December 31, 1887, equivalent to 2,970 10 candle-power lamps.
" " 1888 " 5,500 " "
" " 1889 " 8,953 " "

Quantities of electricity supplied from the works during the past year, as compared with corresponding months of previous year:—

Units supplied.

	1888.	1889.		1888.	1889.
January	7,533	12,689	July	2,687	6,458
February	5,430	10,322	August	4,300	8,390
March	4,550	8,909	September	5,419	10,052
April	4,813	8,401	October	7,615	13,255
May	3,359	7,300	November	12,567	17,261
June	2,707	5,320	December	13,930	19,320

Total, 1888, 74,910 units; 1889, 127,647 units.

equal to an increase for the current year as compared with last year of 70 per cent. During the past year, Mr. Arthur Wright has resigned his position as Managing Director, and Mr. Albert Gay has been appointed in his stead to manage the works. Mr. Gay has already effected economies in working, and the Directors are highly satisfied with him. Mr. Thomas Webber Jerrard has been compelled to resign his seat on the Board owing to the extremely limited time at his disposal; the Board has, however, been strengthened by the election of Mr. Frank Wilden Bentley and Mr. Arthur Kimber. The Directors invited Mr. Kimber to join them, not on account of the amount of his monetary interest in the Company, but because he is a leaseholder and large ratepayer in the district, and is a Director of the Norfolk Hotel, and one of the largest proprietors of the Bedford Hotel, both of which companies are considerable consumers of the electric light. He will, therefore, be in a position to specially serve the interests of the consumers and ratepayers alike. If the Company obtains its Provisional Order, or comes to a fair arrangement with the Brighton Corporation, it will be desirable and agreeable to your Board to invite the Corporation also to appoint a Director to represent its interests and those of the ratepayers generally.

The retiring Directors are Mr. Robert Hammond and Mr. P. A. Latham, who offer themselves for re-election.

NEW COMPANIES REGISTERED.

ANDREWS AND PREECE (LIMITED).—This Company has been registered to carry on the business as heretofore carried on by Thomas Reginald Andrews and Thomas Preece, electrical engineers, of the Borough Mills, Bradford, Yorkshire, adopting therefor an agreement expressed to be made with the said parties, the particulars whereof are not specified in the Articles of Association. Capital, £25,000, in £10 shares, of which 300 are Deferred shares, to be allotted as fully paid-up to the vendors as part purchase-money for the said business, and upon which dividend is to be paid after 6 per cent. shall have been paid on the ordinary shares. Subscribers of one share each are: the vendors above named; Albert Hanson, electrician, Thornleigh, Apperley; John Henry Murgatroyd, Halifax; William Booth Brayshaw, draper, Manningham; Robert Charles Douglas, electrical engineer, Bradford; and James Duff, accountant, Bradford.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The receipts of this Company for the week ended April 4th amounted to £4,134.

DIRECT SPANISH TELEGRAPH COMPANY.—The traffic receipts of this Company for the month of March show an increase of £253 as compared with the corresponding period.

EASTERN EXTENSION TELEGRAPH COMPANY.—The traffic receipts of this Company for the month of March were £41,133, as against £42,896 for the same period of 1889.

ELECTRIC WELDING SYNDICATE.—We understand that the Electric Welding Syndicate is about to launch a large company, with a capital of £460,000, to work the Thomson system.

ELMORE'S COPPER DEPOSITING COMPANY.—The Directors of this Company notify a dividend of 50 per cent., payable, one-half on April 18th and one-half as soon after June 30th as the accounts can be made up.

FAREHAM ELECTRIC LIGHT COMPANY (LIMITED).—The first general meeting of this Company was held recently at the Foresters' Hall, Fareham; Capt. Ramsey in the chair. Mr. James Blake, speaking of the Company's position, stated that a contract had been entered into between them and Messrs. Laing, Wharton and Down, the syndicate working the Thomson-Houston system. He thought the system would prove a beneficial one, and it had been adopted with much success in many parts of the metropolis. A contract for steam-power had been entered into with Messrs. Ransomes, Sims and Jefferies, of Ipswich, for engines of 105 indicated horse-power. They had authority from the Fareham Local Board to enter the town and erect all the necessary plant and appliances for supplying the electric light, subject to the rules and regulations of the Board of Trade. An advantageous site for building a station was at their disposal. He thought the Company would be able to supply the light generally to the town in about three months. A vote of thanks to the Chairman concluded the business.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic returns of this Company for the month of March amounted to £20,800. From the 1st January to 31st March these receipts amounted to £60,200, against, in the corresponding months of 1888 and 1889, £63,800 and £63,000 respectively.

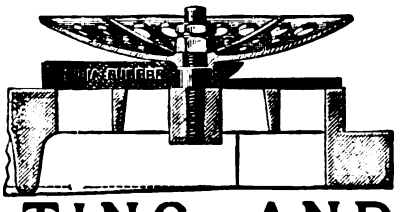
REUTER'S TELEGRAM COMPANY (LIMITED).—The twenty-sixth ordinary general meeting of the shareholders of this Company will be held on Wednesday, the 23rd inst., at noon, at the Company's offices, 24, Old Jewry, London, for the reception of a report and balance-sheet from the Directors, the declaration of a dividend, and the election of a Director and auditors. The transfer books of the Company will be closed from the 8th until the 22nd proximo, inclusive.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The receipts of this Company for the half-month ended March 31st show an increase of £21 as compared with the corresponding period.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended April 4th, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,172.

NEW VALVE

No Rubber, Percha, or Leather.



One-half the price of Rubber or Metal.

FOR CIRCULATING AND AIR PUMPS.

Unaffected by any Lubricating Oils. Does not Expand in diameter. Feed Water may be worked at any temperature Suitable for any shaped guards. Only one quality manufactured.

"12, John-street, Sunderland, 26th Sept. 1885.

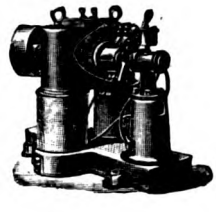
"DEAR SIRS,—In reply to your letter of the 25th inst., the Valves I got from you have done their work well, and ARE AN UNQUALIFIED SUCCESS. I will continue to get them from you as required.—Yours faithfully, JAMES WESTOLL."

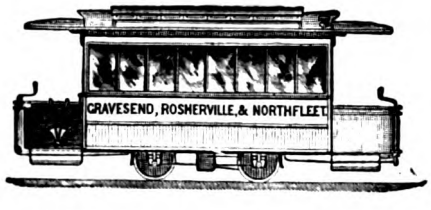
For further Testimony and Prices, apply to MOSSES & MITCHELL, 68-71, Chiswell Street, London.

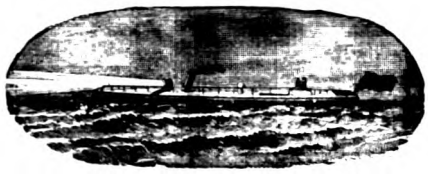
Digitized by Google

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Tuesday, April 1.	Price Wednesday, April 9.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending April 9, 1890. Highest	Lowest
£			**TELEGRAPHS.**			£ s. d.			
1,770,360	Stock	15/0	Anglo-American	49 50	49 50	5 10 0	Jan., Apr., July, Oct.	...	...
2,614,820	Stock	30/0	Do. Preferred	83½ 84½	83½ 84½	6 10 2	,, ,,	84¼	83¾
2,614,820	Stock	...	Do. Deferred	14¼ 14⅝	14 14½	...	February	...	...
130,000	£10	3/0	Brazilian Submarine	12¼ 12⅝	12¼ 12⅝	5 17 8	Mar., June, Oct., Dec.	12⅝	12⅜
112,900	£100	5%	Do. 5 per Cent. Bonds	100 102	100 102	4 18 0	January and July	...	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	104 107	104 107	4 13 6	June and December.	...	...
16,000	10	9/0	Cuba Submarine	11 11½	11 11½	7 16 6	February and August	11	...
6,000	10	10%	Do. Preference 10%	17½ 18⅛	17½ 18½	5 8 1	,, ,,	...	...
12,931	5	2/4½	Direct Spanish (£4 paid)	4 4½	3⅝ 4¼	5 3 6	March & September	...	...
6,000	5	10%	Do. Preference 10%	9 10	9 10	5 0 0	April and October	...	...
60,710	20	3/6	Direct United States	10⅛ 10⅜	10⅛ 10⅜	6 15 0	Jan., Apr., July, Oct.	...	...
380,000	10	2/6	Eastern	14 14½	14 14½	4 11 3	,, ,,	14½	14⅛
70,000	10	6%	Do. 6 per Cent. Preference	14⅜ 15¼	14⅜ 15¼	3 18 8	,, ,,	15⅛	...
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock	106 108	106 108	3 14 1	May and November.	...	...
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	106 109	106 109	4 11 9	February & August	108½	108⅜
250,000	10	2/6	Eastern Extension	14 14½	14⅛ 14⅝	4 17 5	Jan., Apr., July, Oct.	14⅝	14½
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	100 102	100 102	5 17 8	February & August	100½	...
473,000	100	5%	Do. 5 per Ct. (Austln. Gov. Sub.) Debs. 1900	102 105	102 105	4 15 3	January and July	...	...
179,177	10	1/9	Globe Telegraph and Trust	8⅝ 8⅞	8⅝ 8⅞	6 1 1	Jan., Apr., July, Oct.	8⅞	8½
178,992	10	6%	Do. 6 per Cent. Preference	14⅜ 14⅝	14⅜ 14⅝	4 0 8	,, ,,	14⅝	14⅜
150,000	10	5/0	Great Northern	15½ 16	15½ 16	4 13 6	Jan., July, and April	...	...
17,000	25	12/6	Indo-European	41 43	41 43	5 16 3	April and October	...	...
9,000	8	4/0	Reuter's	7 7½	7 7½	5 6 5	April and October	7⅝	...
15,609	10	3/6	West African Telegraph	9½ 10½	9½ 10½	...	...	...	...
300,000	100	5%	Do. 5 per Cent. Debentures	98 101	98 101	4 19 0	March & September	...	...
80,000	10	5/0	West Coast of America	10¼ 10⅜	9⅞ 10⅛	4 15 3	January and July	9⅞	...
150,000	100	8%	Do. Debentures 8%	121 126	121 126	6 7 0	June and December	...	...
88,321	10	nil.	West India and Panama	3⅛ 3½	3⅛ 3⅜	...	...	3⅜	...
34,563	10	12/0	Do. 1st Preference 6%	11⅜ 12	11½ 12	...	April and October	11⅞	...
4,669	10	10/0	Do. 6 per Cent. 2nd Preference	14½ 15½	14 15	...	...	...	...
45,181	15	6/0	Western Brazilian	10½ 11	10⅝ 11¼	6 13 4	May & November	11 3/16	11
$1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	122 126	122 126	5 11 1	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	99 101	99 101	5 18 10	March & September	...	...
			TELEPHONES.						
234,850	14/0	5%	Consolidated Telephone and Maintenance	⅛ ⅛	⅛ ⅜	...	Yearly	...	...
220,000	£1	3%	Oriental (11s. paid)	5/16 7/16	¼ ⅜	4 8 3	...	...	...
80,000	5	3/0	National	5 5¼	5 5¼	...	June and December.	5¼	5⅛
56,000	5	2/0	United River Plate	4½ 5	4½ 5	...	January and July	...	...
			ELECTRICITY SUPPLY COMPANIES.						
555,000	5	...	London Electric Supply	2⅝ 2⅞	2⅝ 2⅞	...	...	...	...
500,000	10	...	Metropolitan Electric Supply (£6 paid)	5½ 6	5½ 6	...	...	...	...
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
190,248	3	...	Brush Electrical Engineering	2¼ 2⅜	2¼ 2⅜	...	...	...	...
353,478	5	7½	Edison and Swan United	...	...	...	...	...	...
409,000	10	...	Electric Construction	9⅜ 10¼	9⅞ 10¼	...	...	...	...
140,000	2	...	Elmore's Patent Copper Depositing	4⅜ 5¼	5⅜ 6¼	...	...	6	5 3/4
41,600	10	10/0	India Rubber, Gutta Percha & T'graph Works	17½ 18½	17½ 18½	5 8 1	February & August	18¼	18
78,949	5	6%	Swan United (£3. 10s. paid)	4½ 5	4⅜ 5	4 3 11	...	...	...
87,650	12	36/0	Telegraph Construction and Maintenance	43 45	43 45	5 6 8	March and July	45¼	44







Before Ordering!

ELECTRICAL PLANT & ACCESSORIES

(Statter's) WRITE FOR THE FOLLOWING PAMPHLETS TO THE (United)

ELECTRICAL ENGINEERING CORPORATION, Ltd.

PLANT WORKS: WEST DRAYTON, near LONDON.
FITTINGS WORKS: ALBERT WORKS, 36, ALBERT EMBANKMENT, S.E.
LONDON OFFICES: 3, PRINCES MANSIONS, VICTORIA STREET, WESTMINSTER.

"ELECTRICAL DISTRIBUTION."—Commercially considered, with Estimates.

"MACHINE DRIVING BY ELECTRICITY."—The Uses of Electro-Motors for Traction and Stationary Purposes.

"THE TELPHER SYSTEM OF CHEAP TRANSPORT," for Minerals, Goods and Passengers.

"ELECTRICAL SUPPLIES."—Prices and Particulars of the most approved Electrical Appliances

ELECTRICAL PLANT ON VIEW.

Digitized by Google

THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 622.—Vol. XXIV. FRIDAY, APRIL 18, 1890. Price Fourpence.

NOTES.

Sir Frederick Bramwell's Paper on "Electric Welding" at the Institution of Civil Engineers on Tuesday night occasioned a remarkable degree of interest amongst the members, numbers of whom could not find room in the theatre. A formidable array of electric welding appliances gave promise of some large-scale experiments; but the most unique feature of the evening was the hammering of a 1⅛in. iron bar on an anvil by two smiths. What would Telford, Brunel, and Stephenson have thought of an anvil ringing and sparks flying from the actual welding of a large iron bar behind the president's chair?

The annual general meeting of the Electrical Trades Section will be held on Monday next. A good attendance is especially desirable on this occasion, as the business on the Agenda Paper includes the election of chairman, deputy-chairman, and committee. It is intended, we understand, to increase the committee from 33 to 48, the number originally proposed.

Mr. Melhuish's Paper "On Signalling across Rivers in India," read at the Institution of Electrical Engineers last Thursday, and which we print this week, is a notable contribution to practical telegraphy, applicable not merely to India, but probably to countries nearer home. The methods employed in the experiments were novel and highly successful, whilst the utilisation of Cardew's vibrating sounder in connection with the sheaths of submarine cables adds one more useful purpose to which that valuable little instrument can be put when ordinary means of communication fail.

After having had an Earl and a Baron to espouse their cause in Parliament—to say nothing of Mr. Redmond and Dr. Tanner—the telegraphists ought to be satisfied that their grievances are receiving highly distinguished, if not very discriminating patronage. Those grievances, so far as they had been previously brought under the Postmaster-General's notice, and on which we commented a week or two ago, are being treated by him just as we suggested they should be. A committee is sitting to inquire into the nature of some which are capable of amendment, and into the reality of others which are of doubtful accuracy. As to the rest, Mr. Raikes frankly told the House of Commons that the demands could never be conceded, and we should say that the telegraphists knew this perfectly well beforehand. One complaint, however, which was strongly dwelt upon by Earl Compton, did not find a place in the public manifesto, namely, the long hours the men were sometimes compelled to work as overtime. No doubt they would like it to be more evenly distributed—so would everybody who works overtime; but we doubt very much whether the telegraphists desire to have their earning power diminished; and, like all other wage-earning classes, they must take the extra duty as it comes, or sacrifice it altogether. With one exception, apart from a few trivial details which may be easily set right, we are still unable to discover any substantial grounds for all this agitation. The exception is in the distribution of the day's work. Extra duty is extra duty, and ought to be paid for in cash, not in release from duty at another time.

We publish this week some further details of Dr. Louis Duncan's tests of Westinghouse alternate-current apparatus alluded to by our New York correspondent in his letter of March 22nd. The efficiencies, although not so high as some recently "figured out" in connection with Ganz plant, are probably more like those which obtain in actual practice. A higher efficiency at full load than 78 per cent. may reasonably be expected from a modern alternator, and in the latest types of Westinghouse machines softer iron and better lamination have no doubt reduced the somewhat excessive loss in the armature core brought to light by these tests.

Some four months ago the Paris Municipality, it will be remembered, requested their technical advisers to inquire into, and report upon, the alleged infractions of the municipal regulations relating to the employment of foreign plant in the Paris central lighting stations. This report was presented last week and discloses a state of things which has aroused the indignation of all true patriots. The Edison Company, *horribile dictu*, have no less than four Babcock and Wilcox boilers, the ends of which are of metal of foreign origin. The worst offender, however, is M. Victor Popp, whose engines have all been obtained from abroad. These and other instances of free trading have resulted in a drastic municipal edict. Within three months all the foreign steam plant in the Paris central stations is to be replaced by French plant. M. Popp's air-compressing and compressed-air engines are, however, given twelve months' grace. Foreign dynamos are to be allowed to stay where they are, but the currents generated by them will not be permitted to mingle in fraternal union with French currents; for in Article 3 of this remarkable decree it is stated "that

Digitized by Google

the currents generated by electrical machines built abroad are not to enter the private-lighting mains;" and Article 5 forbids connection with the service mains until the Commission Technique has ascertained that all the plant of a central station has been manufactured in France. M. Popp has already stated his inability to procure satisfactory compressed-air plant in his own country; and if the Dandeu-Naze machine is a fair specimen, there would seem to be much the same difficulty with regard to large alternators. Municipal meddling bids fair, therefore, to prove as detrimental to electric lighting progress on the French as on the English side of the Channel.

We have received a communication from Mr. Keeley, of Ottawa, in reference to our article on his proposed system of working long submarine cables, which appeared in *The Electrician* of December 20th last. Mr. Keeley denies that there is anything in his specification which indicates a want of knowledge of the laws governing the transmission of currents. We think it only necessary to say, in reply, that the expressed object of his proposed system is to *eliminate retardation*, and that "polarised receiving instruments are called for under his invention." Mr. Keeley refers to a cable company which has in operation, on a 500-mile circuit, a polarised relay working with the greatest facility, and we also are aware of an instance where a polarised relay, after working well for many years, on a cable 620 miles in length, was aban doned for a recorder. Neither of these cases, however, proves anything with regard to a cable 1,000 miles in length, and still less in respect to one of the Atlantic cables.

On reference to the conclusion of our article Mr. Keeley will see that we did not imply, as he states, that he "proposed sending reversed currents from the transmitting end," that being the feature of another system, certainly not Mr. Delany's, as he assumes, which we said was similar to Mr. Keeley's in *other respects*. Mr. Keeley's letter concludes as follows:—"The *distinctive feature* of my invention is the application of a commutator at the *receiving* end of the circuit, whose alternating currents operate to neutralise or augment the currents emanating from the transmitting end, and the polarity of the latter is what determines the position of the needle or lever of the receiving instrument." From this and the following excerpt, those of our readers who are acquainted with the working of submarine cables will form their own opinion as to the probability of success on long cables of Mr. Keeley's system:—"The application of current to *both ends* of a cable gives rise to new conditions—that is, *different* from what is observed with currents applied at one end alone as heretofore." It is no doubt adaptable for land-line working, but instruments are at present in use over which Mr. Keeley's invention does not show any superiority, and we are unable to modify our views with respect to his system as applied to submarine cable work. This is a subject which has received a vast amount of attention from the leading telegraph engineers throughout the world, and we should be very pleased if Mr. Keeley should yet succeed in overcoming what appear at present to be insurmountable difficulties.

The liquidation of the Submarine Telegraph Company's affairs is now virtually completed; and whatever may be said of its management as regards the closing period of its existence, there can be no question as to the prudent and far-seeing policy pursued during the years preceding. A large reserve fund was accumulated, and invested so advantageously that the securities have been sold at a profit of over £26,000; and after paying off the shareholders in full there remains a balance to be distributed, after all claims are settled, of probably little short of 8 per cent. of the capital. The shareholders, although to be commiserated on the compulsory sale, may be congratulated, all things considered, on the final result. We are sorry to add that the same cannot be said of their employés, many of whom have been treated rather shabbily by this wealthy corporation.

By Section 4,887 of the Revised Statutes of the United States it is enacted that "every patent granted for an invention which has been previously patented in a foreign country shall be so limited as to expire at the same time with the foreign patent, or, if there be more than one, at the same time with the one having the shortest term, and in no case shall it be in force more than seventeen years." As our readers will recollect, the question as to what was meant by expiry at the same time as the foreign patent has been the subject of several contradictory decisions in the United States Courts. The matter is one of especial interest to American electricians, since a number of Edison's leading incandescent lamp patents are concerned. In January, 1889, the United States Supreme Court rendered a decision on this point, in the case of the "Bate Refrigerating Company *v.* Hammond;" and a still more conclusive judgment has just been given by the same Court in another patent action of a similar kind. In their last judgment the Supreme Court clearly state that the words "expiration of term" do not mean expiration of term through a forfeiture by breach of a condition, but mean expiration by lapse of time. Thus an American inventor who takes out a patent for his invention in Germany is by this decision no longer liable to forfeit his American patent because, for instance, he fails to pay the annual increasing tax required by the German law, and thus allows his patent in that country to lapse. The American patent is now held to run for the full term of years expressed on the face of it. This decision seems to be in accordance with the spirit of the statute and with common sense.

An important decision in connection with an electrical patent has also recently been rendered in the United States District Court, where it has been decided in an action between the Brush and Julien Companies that the Brush storage battery patent covers every battery in which the active material is applied to the plates by mechanical means. In November last, it will be remembered, the Electrical Accumulator Company obtained an injunction against the Fourth Avenue Railroad, who were running some Julien accumulator cars, which prevented that Company from using cells in which the active material had been applied to the plates in the form of a "paint, paste, or cement." This little impediment was promptly overcome by the Julien

Digitized by Google

Company, who set to work to make plates in which the active material was applied in the form of *powder*, and submitted to an enormous pressure. The latest decision, however, seems to cover the whole ground, and it is needless to say that an action is now pending between the Brush Company and the Electrical Accumulator Company.

Cordova.—The public lighting of Cordova by means of 180 arc lamps will be commenced on May 1st next.

The Rating of Machinery.—The Rating of Machinery Bill was read a second time in the House of Commons on Wednesday night.

Hanover.—From the *Elektrotechnische Zeitschrift* we learn that the authorities of Hanover have rejected the electric lighting proposals of the Popp Company.

London Chamber of Commerce.—At the last meeting of the London Chamber of Commerce, Sir Albert K. Rollit, M.P., was elected Chairman for the ensuing year.

Plymouth.—At a special meeting of the Town Council, held on Wednesday, consent was given to the application of the Devon and Cornwall Electric Supply Company for a Provisional Order.

The Lighting of the City.—A deputation, consisting of ten members of the London Commissioners of Sewers, visited Taunton on Friday last to inspect the public lighting by electricity.

Wandsworth.—At a special meeting of the Wandsworth District Board held last week, consent was given to the application of the House-to-House Electric Light Supply Company for a Provisional Order.

Rapid Telegraphy.—On March 5th Mr. Lee Cook, of Mexico, received a telegram with reference to the Pan-American Congress, containing 1,369 words, in less than two hours after it was handed in at Washington.

Telephonic Extensions.—On Tuesday last week the National Telephone Company celebrated the opening of their Dumfries and Carlisle trunk line, which opens up telephonic communication with Carlisle and West Cumberland.

Electrical Oscillation.—On Wednesday evening Dr. O. J. Lodge delivered an interesting lecture to the Glasgow Philosophical Society on "Electrical Oscillation." Prof. M'Kendrick presided, and there was a large attendance.

Royal Society.—At the last meeting of the Royal Society, amongst the Papers down for reading was one by Profs. Rücker and Thorpe, F.R.S., "Preliminary Note on Supplementary Magnetic Surveys of Special Districts in the British Isles."

The French Exhibition.—The exhibits at the forthcoming French Exhibition at Earl's Court are divided into 11 groups, Class III., Group IV., being partly devoted to electricity. The Exhibition will be opened on Saturday, May 10th, by the Lord Mayor of London.

Edinburgh Exhibition.—At the last meeting of the Executive Council it was announced that the Duke of Edinburgh had consented to open the Exhibition on May 1st. It was decided to build an additional annexe of about 5,000 square feet, to accommodate the French electrical exhibits.

Telegraph and Electric Wires in Canada.—The Great North-Western Telegraph Company of Canada have decided to protect its wires from crosses with electric light wires, and have issued general orders to its linemen to string a dead wire above their wires at all points where the same are crossed by electric light conductors of any kind.

Hertford.—At a recent meeting of the Town Council a resolution refusing to consent to the Provisional Order of the Hertford Electric Light and Power Supply Company was adopted; and the Council resolved to make an application itself, and to enter into an agreement with the Company to lay down the installation and supply the light.

Scarborough.—The Board of Trade has requested to be informed as to what steps have been taken by the Corporation to give effect to the powers contained in their Provisional Order, or if no such steps have yet been taken, to be furnished with some further assurance as to the time within which the Corporation are prepared to commence the supply of electric energy under their Order. It has been resolved to inform the Board of Trade that the Corporation are prepared to undertake to put in force the powers contained in their Provisional Order within a period of 12 months.

Thermo-Electric Tension between Compressed and Uncompressed Mercury.—Dr. de Coudres, of Leipzig, is reported to have succeeded in detecting a thermo-electric tension between compressed and uncompressed mercury. The compression was produced either hydraulically or by means of its own weight acting through a column of mercury. It was found possible to determine with certainty the direction of the thermo-electric current, and to measure its intensity for given pressures and temperatures.

Physical Society.—In the discussion on Mr. Mather's recent Paper, at the Physical Society, "On the Shapes of Movable Coils used in Electrical Measuring Instruments" (*The Electrician*, April 11, p. 578), Mr. C. V. Boys observed that "He himself had found, while working at the radiomicrometer, that No. 1 was the most advantageous shape." We are desired to state that this remark was not intended to convey the idea that Mr. Boys had, previously to Mr. Mather, found by actual calculation that this particular shape was the best, but only that his investigations had led him to much the same result.

Obituary.—General Sir John Henry Lefroy, K.C.M.G., C.B., F.R.S., LL.D., who died on Friday evening last, at Lewarne, a few miles from Liskeard, entered the Royal Artillery in 1834, and was director of the Magnetical and Meteorological Observatory at St. Helena from 1840 to 1841, whence he moved to a similar position at Toronto in 1842. During the next year he made a magnetic survey of the interior of North America, from Montreal to the Arctic Circle, and was subsequently scientific adviser to the Duke of Newcastle at the War Office on subjects of artillery and inventions from 1854 to 1855.

Toronto.—The City of Toronto's contract with the Toronto Electric Light Company expires at the end of the present year, says the *Electrical, Mechanical, and Milling News* of that city. In view of this, a committee of aldermen has been appointed to secure information on the following points: "What is the best system of electric lighting now in use? What would be the cost of a plant, &c., required to furnish 1,000 arc lights on the overhead system? The cost of the underground system. Whether the same machinery can be used for a combined underground and overhead system? What success has attended the underground system?" The city professes to be seriously considering the advisability of purchasing and operating its own electric light plant.

The Imchenetzki Battery.—In this battery the exterior containing cell is of tinned iron, with a base of cast iron. The interior cell, open at the base, is of paraffined cardboard, and contains eight porous diaphragms. Melted paraffin wax is poured at the bottom of the first cell, and when this is cold the second is introduced. There are thus nine compartments perfectly insulated, of which four contain sulphite of soda with plates of zinc, and the other five are filled with chromic acid with electrodes of specially prepared compressed graphite. In certain types both electrodes are of graphite. The E.M.F. of this battery is 2·12 volts, or 0·8 volt if both electrodes are of graphite. The battery, when short-circuited, gives a very constant current for several hours.

Eastbourne.—At the last meeting of the Town Council, a letter was read from the Board of Trade with regard to the charges of the Electric Lighting Company, and stating that the price should be 8d. instead of 10d. per unit. After some discussion, Councillor Wenham moved, and Councillor Ford seconded, "That the Corporation saw no reason why the Board of Trade fixture of 8d. should not be accepted," and on a show of hands the Council decided to act as the Board of Trade advised. Alderman Wallis strongly objected to the vote thus suddenly taken, on the ground that no time had been allowed to the members of the Council to consider the

Digitized by Google

Board of Trade letter before expressing an opinion upon it. The vote really meant the death of the electric light in Eastbourne, and with it the prosperity of the town.

Interruption of Shetland Telegraphic Communication.—A serious interruption, says the *Glasgow Herald*, has occurred in the telegraphic communication between Lerwick and the north isles of Shetland, owing to the breaking of the cable between the islands. A direct cable was laid some time ago, but the section between Unst and Yell gave way about a month since, and messages have for some time back been conveyed across Bloomel Sound by boat. Now, however, it is believed that the Yell Sound cable has also broken, the result of which will be to entirely cut off the two islands. Even should the fears as to the latter cable be groundless, the fact of the Unst cable being broken is serious enough, as it leaves the whole island of Unst dependent on a boat service during the spring cod-fishing, one of the most important fisheries of the year.

The Halifax-Bermuda Cable.—In the House of Commons on Tuesday Sir E. Watkin asked the Postmaster-General what was the cause of the delay in laying the cable contracted for by Her Majesty's Government with a private company between Halifax, Nova Scotia, and Bermuda; and when might the public expect that the cable would be in operation. Mr. Raikes replied that under the power given to the Treasury by Section 4 of the contract with the International Cable Company the time allowed for laying the cable had been extended to Midsummer next, so as to avoid the risks attending any attempt to lay the cable during the winter months. He was not able to state the precise date when the cable would be available for traffic. No doubt the Company would do all in its power to complete it at the earliest date, because the subsidy did not become payable until the cable was in working order.

Electric Soldering.—The development of electric welding has naturally led to the invention of devices by which heat may be applied in a somewhat similar manner in other processes in the arts. Prof. Elihu Thomson has recently devised an apparatus by which the heating power of the current is utilised in the process of soldering the covers of tin cans. The apparatus consists merely of a converter, with its secondary terminating in a metal ring, the lower edge of which coincides with the line of solder about the edge of the lid of the can. In order to insulate the ring from the can, mica is interposed. The mica is protected from injury by being itself faced with a thin ring of metal. To operate the device the current is switched on until the ring is brought to the proper temperature. The tin can, which is carried by a weighted lever, is then pressed up against the heated conductor. While the process described relates to the soldering of cans, Prof. Thomson has applied the method in other processes where materials are united by the employment of heat to fuse the uniting material.

Weybridge.—A public meeting was held last week to determine the amount to be raised for street-lighting purposes during the coming year. Dr. Sealy, one of the lighting inspectors, said they estimated that they would require £260 for the next year for lighting; and a 2¼d. rate would produce £264. He claimed that the inspectors, in providing the electric light for the modest rate of 2d. in the pound, had achieved a good deal. The cost of putting the wires underground would be £200 per mile, exclusive of the lamp-posts, which would cost about 30s. each. They had something like six miles over which the lighting extended; and there were 18 lamp-posts per mile. The contractors had offered, if the parish constructed the necessary earthenware conduit, to put in the wires and remove the present poles and overhead wires without additional cost. It was purely a question for the ratepayers as to whether the underground system should be adopted. After some discussion an amendment that the rate be 2¼d. was proposed and carried. It was suggested, but the idea did not appear to meet with approbation, that a subscription list should be opened for placing the wires underground.

The Henry Gearing for Electric Car Motors.—Mr. J. C. Henry, one of the earlier workers in the electric motor field, has recently devised a means of connecting the electro-motor to the car wheels, admitting of the former running continuously in the same direction, irrespective of the direction or motion of the car. The motor is placed on the front platform of the car; and its armature, instead of its being connected directly to the car axle by chains or gears, acts on a pair of friction wheels mounted upon a movable collar, which drives an oblique axle, carrying on its lower end a gear wheel to engage the driving wheel mounted on the car axle. By a lever on the car platform either of the friction wheels can at will be engaged with the friction wheel on the armature spindle, and consequently the oblique shaft can be given a rotation in either direction without changing the direction of the rotation of the motor. The friction wheels used in practice are of wood, and are reported as giving a firm hold and excellent service. The experiments tried with this mechanism have been quite satisfactory in their character; but Mr. Henry is now at work improving and modifying it, and in his later arrangements the motor and the driving devices are placed below the floor of the car.

A Simple Storage Battery.—The following directions for making a simple storage battery is due to the *Journal of the Telegraph*. Get two half-round porous cups and a round glass jar large enough for the two porous cups to stand in upright. Get two plates of sheet lead one-sixteenth of an inch thick, wide enough to fit the half-round side of the porous cups and deep enough to come an inch or so above the top edge of the cups and jar. Solder a stout copper wire or a screw post to each lead plate at the top. Place the lead plates in the cups and fill the cups nearly full with a paste made of red lead mixed with a solution of sulphate of soda thin enough to run like a cement. The glass jar containing the two cups should be filled to within half an inch of top of cups with sulphuric acid and water, about one part of acid to eight parts of water. The plates should be marked so that, in charging, the currents may be sent in the right direction. The cell may be charged by attaching to a series of a dozen sulphate of copper cells for 24 hours, or from a dynamo. A wooden cover may be fitted to the glass jar, and evaporation of the fluid should be replenished by adding water. Two or more cells of this battery will work small motors, lamps, and induction coils, and if thoroughly charged will retain a large volume of electricity for a considerable time. After once being well charged, four to six cells of sulphate of copper battery will recharge it.

Copper.—About a year ago, says *The Statist*, the copper "corner" came to a disastrous end, and the copper trade has since resumed something like a normal course. The stock of copper is still very large in comparison with stocks before the "corner" was initiated; but, nevertheless, it is being steadily reduced, production falling off and consumption being stimulated, as a consequence of a low range of price. The copper corner began in October, 1887, when the stock in England and France and afloat from Chili and Australia stood at 49,176 tons. The deliveries previous to that date averaged about 8,000 tons per month, but during the first three months of the speculation they averaged about 12,000 tons, falling in January, 1888, to a little under 6,000 tons. From that time till the collapse of the speculation, in March, 1889, the deliveries in any single month never exceeded 6,212 tons, and in February, 1889, they only amounted to 1,397 tons. The average monthly delivery in 1888 was only 5,300 tons. Simultaneous with this small rate of consumption during the "corner" period, supplies became very large; and whereas in 1887 the monthly supplies only averaged about 7,500 tons, in 1888 they averaged nearly 10,500 tons. The consequence was that stocks rose rapidly, until in March, 1889, they reached the enormous chronicled total of 124,876 tons. This, of course, was irrespective of invisible supplies. The natural consequence of the great fall in prices which occurred last year, and the large amounts offered, have been two-fold—consumption has expanded, and production has diminished. The figures of the twelve months ended March 31, 1890, show that with a supply of about 9,000 tons per month, the deliveries—that is, the consumption—averaged 11,750 tons per month, and the stock has been reduced from 124,876 tons in March, 1889, to 91,938 tons in March, 1890. Although prices are so low compared with the exorbitant prices demanded during the "corner," yet they are £7 a ton higher than the prices current before the "corner," and are sufficiently high to yield a moderate profit to producers.

Digitized by Google

MAGNETISM IN IRON AND OTHER METALS.*—XIV.

BY PROF. J. A. EWING, F.R.S.

(*Continued from page 568.*)

§ 64. **Magnetisation of Iron Rods of Various Lengths.**—The curves of Fig. 32 are selected from a group of experiments in which an annealed wire of soft wrought iron, originally 300 diameters long, was tested by the ballistic method, first in its full length and then after the length had been reduced successively to 200, 150, 100, 75, and 50 diameters by cutting off equal portions (in each case) from the ends. The central part of the length, through which the magnetic induction was measured, remained unchanged throughout the series. After each magnetisation the rod was reduced to a neutral state not by the process of reversals, but by taking advantage of the fact that a soft iron wire loses sensibly the whole of its residual magnetism when it is briskly tapped. Soft iron is extraordinarily sensitive to the effect of vibration; to tap it when the magnetic force is in action very greatly increases the permeability, and to tap it when the force is removed does away almost completely with its retentiveness. So sensitive is it that when the magnetic force is removed the lightest touch of the fingers suffices to destroy much of the residue, and after brisk tapping only one or two per cent. will in some cases be found to remain. The residual magnetism of soft iron is in fact very insecurely held. So long as the metal is left perfectly at rest it does not appear to suffer loss through the mere lapse of time; but any variation of temperature, or mechanical disturbance of whatever kind, reduces it with remarkable rapidity.

The three curves selected for reproduction in Fig. 32 refer to the cases where the length was 200, 100, and 50 times the diameter respectively. The abscissæ give the magnetising force exerted by the solenoid, not the true H, as affected by the ends of the specimen. To give some idea of the true H, the lines O A, O B, and O C have been drawn; these show the reactions which ellipsoids of 200, 100, and 50 diameter respectively would exert. By measuring the magnetic force from them instead of from O Y, we get an approximation to the true value of H. The approximation is a very fairly correct one for the rods of 200 and 100 diameters; the curves for them when, rectified by taking abscissæ from O A and O B respectively, agree well with one another, and with curves for longer rods or rings of the same material. The diagram shows well what has already been sufficiently explained—how it is that soft iron shows little retentiveness when tested in the form of a short rod, though it shows much when tested as a long rod or as a ring. The broken lines show the gradual reduction which the magnetism suffered as the magnetising force of the solenoid was reduced to zero. By producing them past the axis O Y to cut O X produced we find that the "coercive force" of the material was 1·9, as in the experiment of Fig. 31, § 63, which dealt with another specimen of the same annealed iron wire.*

§ 65. **Wrought-Iron Bar.**—Fig. 33 is copied from a Paper by Hopkinson,† and refers to a ballistic test of annealed wrought iron by the method of the yoke (§ 59). The magnetic force was raised to 240, then reversed and re-reversed; but in the figure

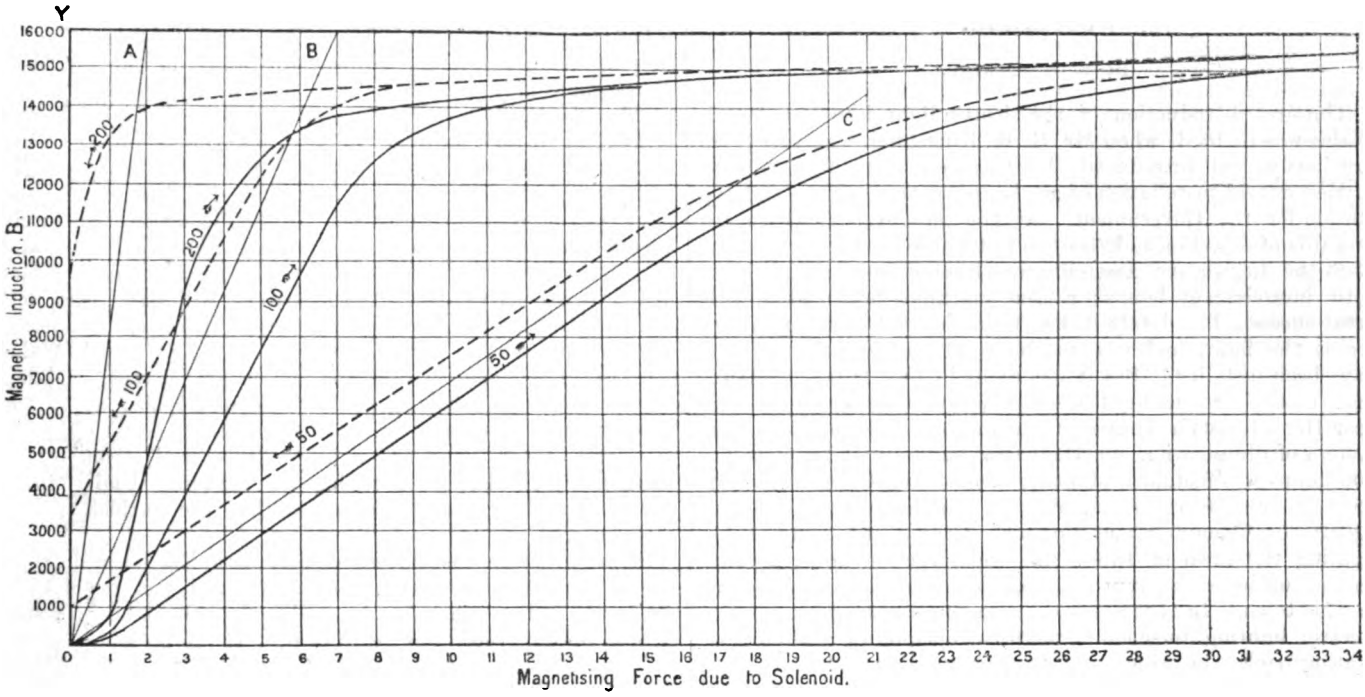


FIG. 32.—Magnetisation of Soft Iron Rods of various lengths.

the negative magnetisation and the parts relating to high forces are omitted. A comparison of this figure with those that have

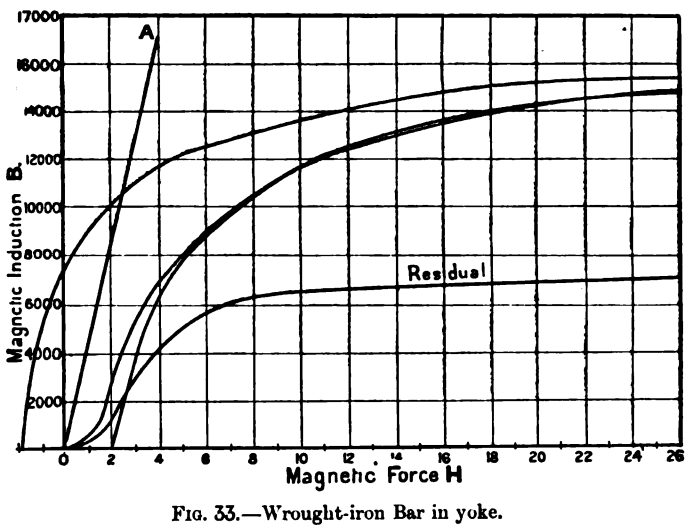


FIG. 33.—Wrought-iron Bar in yoke.

been already given suggests that the condition of endlessness was imperfectly realised (in great part, no doubt, through the

* All rights are reserved.

* In further illustration of the effects of length in the magnetisation of rods, see a Paper by A. Tanakadate, *Phil. Mag.*, November, 1888, where experiments are described dealing with a series of rods shorter than those referred to in the text.

† *Phil. Trans.*, 1885, plate XLVII.

Digitized by Google

action of the plane of section referred to in § 58), and that the curves might be approximately rectified by measuring H from a line such as O A (which has been added in copying the figure). This would make the bar within the yoke equivalent as regards endlessness to a bar (with free ends) about 150 diameters long. The coercive force in this sample has a value almost identical with the value found in soft iron wire, which strengthens the view that it is to imperfect endlessness, rather than to any specific difference in the quality of the iron, that one is to ascribe the comparatively small retentiveness of this bar.

(To be continued.)

THE PROGRESS OF THE ELECTRIC LIGHT IN AUSTRALIA.

BY E. J. ERSKINE.

The first introduction of the electric light into New South Wales was in 1881, when Mr. H. H. Kingsbury, who two years previously had introduced the telephone into this colony, carried out an installation of arc lamps at the Redfern railway station for the Government. At the present time there are upwards of 5,000 incandescent and 500 arcs in the colony. In 1883 the Legislative Assembly was lighted by the same firm with incandescent lamps; Edison machines were used with great success, but lately it has been deemed necessary to increase the light, and new machines of the Manchester type have been installed. But it was really in 1887 that the advantages of the electric light were properly recognised. In this year Her Majesty's Theatre Company decided to adopt this system of illumination for their new building, and a plant for 900 lamps was installed, Manchester machines being used. In 1888 Messrs. Harrison and Whiffen appeared in the field as agents for Crompton and Co., and secured the contract for lighting the town of Tamworth, where they installed a plant on the continuous-current system, which has given satisfaction in the town. In 1888, also, an impetus was given to the electric lighting business through the opening of a number of skating rinks, in which the proprietors desired to have the electric light; but as these installations were nearly all of a temporary nature, the work was not of a character to be encouraged, switches, cut-outs, ampere or volt meters being conspicuous by their absence. It would be more satisfactory to all parties concerned if the fire underwriters' rules were more stringently enforced; as although we have so far been very fortunate in Australia, having had no accidents that could be attributed to the electric light, it is more by good luck than good management; and now that the number of installations is increasing, it is most necessary that every precaution possible to prevent accidents should be taken.

Last year was a busy year in electrical circles in all the Colonies: in Melbourne on account of the extensions of central stations, and in New South Wales on account of the number of country boroughs who called for tenders; but perhaps the most important event of the year was the introduction into New South Wales of the first alternating-current transformer plant installed by Messrs. Kingsbury and Co. in Young. This plant is on the Thomson-Houston system, and the success has been such that the firm have received the contracts for Penrith and Lambton. It should, however, be mentioned that although this is the first introduction of the alternating-current in New South Wales, both the Thomson-Houston and Ganz and Co. have been working the system in Melbourne for some time with great success.

So far as motive power is concerned there appears to be a general leaning towards engines of the semi-portable type, and it is an exception when a plant is erected with separate boilers and engines. The standard of work done by firms in Sydney has been gradually improving during the last few years, and now it has reached a creditable pitch; the installations at the offices of the *Daily Telegraph*, and that in the new hotel in Bent-street—being the latest additions in Sydney—are in every respect highly satisfactory; also the temporary lighting of the Centennial Hall with arc lamps reflects great credit on the contractors. Perhaps the first thing that would strike an electrician coming here and going round the different installations would be the deplorable lack of ventilation and space in the engine and dynamo room, with one or two exceptions—a state of things highly detrimental to efficient working of the plant. Architects might be forgiven for not knowing that ventilation is a great advantage in dynamo-rooms from a commercial standpoint; but they should not lose sight of the fact that the attendant requires air to make it possible for him to look after his machinery. In one case the attendant is nearly suffocated by the fumes from some accumulators. It seems to be the general impression that any hole is good enough for electrical machinery.

Up to the present there is no central station lighting in Sydney; whereas in Melbourne there is a considerable amount of lighting done from the stations in operation, and there are other stations in contemplation. The reason for this difference in progress between the two largest cities in the Southern Hemisphere may perhaps be accounted for by the fact that in Sydney the Gas Company have a monopoly of the lighting; and although two Bills have at different times been introduced to enable companies to erect central stations and supply light and power, they have never got beyond the first stages, and have then been allowed to lapse. In Brisbane there has lately been a considerable movement towards the electric light; and central stations will, I think, shortly be an accomplished fact in the Northern Colony. If so, Sydney will have been left behind by all her neighbours, as at present there are no rumours of a central station here. However, the New South Wales country municipalities are, to a certain extent, making up for the indifference shown by the metropolis, as at the present time there are two of the interior towns lighted, in three others the work is in progress, and seven others are either considering or calling for tenders. Under these circumstances it must be admitted that the outlook is very promising.

So far as traction is concerned, very little has been done in any of the Colonies. Some time ago a trial was made of a car on the Julian principle; but, although the trial was successful, nothing more was heard of it. At the present moment an electric tramway is talked of for Balmain, a suburb of Sydney, and I believe it is to be on the Sprague system. Victoria once more takes the lead in the matter of electrical tramways, having one at Box Hill which is giving satisfaction; although I hear the rails through which the return is made are not all that could be desired, the joints being very primitive, and therefore the resistance very great.

There is one matter that is doing a considerable amount of damage to the electrical industry. I refer to the exaggerated reports that appear from time to time in the daily papers, copied from home papers, of the dangers of electric lighting in general and of overhead wires in particular. Many persons in the country districts reading these articles immediately imagine that the introduction of the electric light is nothing more or less than the introduction of a new kind of plague.

The subject, perhaps, most under consideration here at present in the country municipalities is, whether arc or incandescent lighting should be adopted for street lighting. The great argument relied on by the advocates of arc lighting is, that whereas it requires 500 horse-power to obtain 100,000 candle-power with incandescent lamps, the same number of candle-power would be obtained with 50 horse-power with arc lamps. Of course this is absurd; but they will not understand that the two systems cannot be compared by their nominal candle-power. So far, the five municipalities who have decided on the electric light have adopted the incandescent with good results, and it certainly hardly seems necessary in towns of 6,000 inhabitants to go to an enormous expense of lighting the town with arc lamps, the night traffic being quite insignificant.

In Victoria the railway authorities are turning their attention to the lighting their trains by electricity, and once more the younger colony will be ahead of New South Wales, as the system now in vogue here is an elaborate system of gas illumi-

Digitized by Google

nation, the installing of which involved a large outlay; and it is, therefore, not probable that the authorities will, for some time at any rate, consider the question of electric lighting, which would necessarily entail another large expenditure.

The prospects of electric lighting in the other Colonies, viz., New Zealand and Tasmania, should be very good, the abundance of water-power which is at the disposal of engineers giving every opportunity for the electric light to compete with any other system of illumination.

THE LIGHTING OF CHELMSFORD.

On Monday evening last the contract for the lighting of the streets of Chelmsford was commenced by Messrs. Crompton and Co. (Limited). The occasion appeared to be one of considerable interest and enthusiasm to the inhabitants of Chelmsford, as well as to the Mayor and Corporation of the town and those who were invited by Messrs. Crompton and Co. to witness the ceremony of inaugurating the lighting and to inspect the plant and lighting arrangements. On arriving at Chelmsford, the arrangement of the lamps and overhead wires in the streets was inspected by the visitors as they passed through the town on their way to Messrs. Crompton and Co.'s works. Mr. Crompton then conducted a number of those present over the extensive and ever-growing works of his Company, where a large dynamo, which has been constructed by Messrs. Crompton to the order of an American firm, attracted great attention. The machine has an output of 2,500 amperes and 60 volts when driven at 400 revolutions per minute. It is of the 4-pole drum-armature type, each convolution of the winding enveloping only one-quarter of the circumference of the core. The bars and end connections of the winding are joined together by means of iron set screws, and it is stated that in the event of a fault occurring the whole of the winding could be removed from the core within the space of an hour.

At about 7 p.m. the ceremony of switching on the lights for the first time under the contract was performed by Miss Brown, the daughter of the Mayor, and Mrs. Chancellor, the wife of the ex-Mayor of Chelmsford. At 7:30 p.m. a banquet to celebrate the event took place at the "Saracen's Head."

The generating plant is situated in Messrs. Crompton's Works, and consists of a vertical main driving engine, by Messrs. Marshall, Sons, and Co., which can be worked up to 150 horse-power. The stand-by engine is a horizontal one, by the same makers. The engines drive a main countershaft by means of rope gearing, the dynamos being driven from the countershafting by bands. The dynamos for the alternating currents are of the Mordey type, and those for the arc-lighting of the Crompton type. The alternator at present fixed is a 50 horse-power (37,500 watts) machine. The arc-light dynamo is capable of driving 20 lights in series of 2,000 candle-power each; it is separately excited, and runs at 900 revolutions per minute. 18 arcs are employed in the main thoroughfares, separated by distances varying between 50 and 110 yards. The lamps are of Messrs. Crompton's well-known type, and are carried on the top of wood or iron posts at a height of 25ft. from the ground. Clear globes are employed, and the effect is very satisfactory. The lighting of the less important streets, &c., is effected by means of 210 32 candle-power incandescent lamps, which are run in sets of 10 from converters. The lamps are arranged in lanterns of about 2ft. 6in. diameter; the roofs of which are curved and painted white, while the sides are of clear glass and slope inwards, formingan apex at the bottom. The lanterns are spaced from 40 to 70 yards apart; but as no opportunity occurred for forming an opinion as to the efficiency of the incandescent lighting, we must reserve our judgment until some future occasion.

The wires are carried almost entirely overhead, on posts erected at the edge of the curbstone. The cables are suspended from iron wires, which are supported by porcelain insulators. These are threaded upon a vertical bar carried by two brackets extending from the post. The arrangement has a decidedly neat and workmanlike appearance, and where there are two wires only, running straight down on one side of the street, the effect is certainly not displeasing. Where, however, the number of cables is greater and they branch out in several directions, the insulators and their supporting brackets being ranged at varying angles round the pole, there is no denying that the arrangement is somewhat unsightly. In the centre of the town, for a short distance, the cables are carried underground. The installation, altogether, does great credit to Messrs. Crompton and Co.; and we wish it every success.

SOME TESTS ON THE EFFICIENCY OF ALTERNATING-CURRENT APPARATUS.*

BY DR. LOUIS DUNCAN AND MR. W. F. C. HASSON.

Several Papers have appeared lately on the efficiency of alternating-current transformers, some of which have been of a more or less theoretical nature, while others have given the results of actual tests. I have never, however, seen any tests on alternating-current dynamos, excepting the experiments made by Dr. Hopkinson and Professor Adams on a de Meritens machine used for lighthouse work. Even the converter tests have given such varying results that one can hardly be certain as to the real efficiency. The introduction of the alternating system has been so rapid and is so rapidly increasing that people are apparently well enough pleased with the results not to bother about the smaller question of the reasons for them. But whatever the results may be, it is of value to know just where the losses in any system may come in, so that we may seek how to avoid them; if we are succeeding, it may enable us to increase the profits; if we are losing, it may help us to avoid further loss.

The apparatus, the measurement of which is the main subject of this Paper, consisted of a Westinghouse 750-light No. 1 dynamo, with a No. 2 exciter and an outfit of 40-light converters. This apparatus had been presented by the Westinghouse Electric Company to the Johns Hopkins University, and was tested a couple of months ago. The workmanship of the machines is excellent. The plant consisted of a 75 horse-power Armington and Sims engine driving the dynamo and exciter through a Tatham transmission dynamometer. Engine, dynamometer, and dynamos were firmly secured to heavy parallel timbers which served as a foundation. The converters were banked on a wooden framework at a distance of some 30 yards from the dynamo, and their primaries were permanently secured to the dynamo circuit, a switch in the latter serving to cut them off when desired. The ammeter belonging to the plant was put in this circuit and was read when efficiency measurements were being taken. The secondaries of the converters were taken to a switchboard and then to incandescent lamps mounted on racks.

Power Measurements.—The Armington and Sims engine supplying the power worked regularly and satisfactorily and the governor could be adjusted to give the speed required at the dynamo. The Tatham dynamometer was the one used for power measurements at the International Electriacl Exhibition held in Philadelphia in 1884, where its accuracy was checked by making with it a determination of the mechanical equivalent of heat. The result obtained in the latter measurement was 772·8 foot-pounds per degree Fahr., and shows that the dynamometer is practically accurate. A description of the experiments and of the instrument may be found in the report of the test made to the Franklin Institute, but it will not be out of place to briefly describe the apparatus here.

An endless belt, as shown in Fig. 1, passes over the driven pulley S, to the shaft of which the engine is belted, round the pulleys S_2 and B, to the driving pulley A, and back over B_1 and S_1 to S again. The bearings of the pulleys B and B_1 are in cradles pivoted on knife-edges, C, at their outer ends, and at the inner ends are connected by links at equal distances on the two sides of a knife edge which supports the scale beam, W. The outer side of the belt passes through the line of the knife edges, C, and therefore has no effect on the scale beam, but the tensions of the inner parts of the belt act directly on the scale beam, and as they are on opposite sides of the fulcrum they act against one another. The beam is so graduated that this difference of tension is read off directly in pounds, and this quantity—the difference of tension of the belt on the two sides of A—multiplied by its circumference and speed, gives the horse-power delivered. A weight travels on the beam W, and readings can be taken with great accuracy.

* A Paper read before the American Institute of Electrical Engineers March 18 1890.

Digitized by Google

Electrical Measurements.—The energy in the secondary circuit was measured by means of a Cardew voltmeter and a Thomson ampere-balance. As it is not the custom to put a number of secondaries in parallel, each converter had its separate lamp circuit.

Before making any efficiency test, the potential difference in the primary was regulated—there being a Cardew voltmeter in that circuit—and a separate measurement of the potential difference and current in each secondary circuit was made. When the test was actually in progress, the voltmeter and ampere-balance were used in one of the circuits, and the currents and potential differences in the others were calculated from the readings in this circuit together with the previous measurements. Both the voltmeter and ampere-balance were accurately calibrated, the former being checked after each test, while the latter had its constant determined with both continuous and alternating currents. The potential difference at the terminals of a non-inductive German-silver resistance in circuit with the balance was observed when a continuous current was flowing, and also with an alternating current of the same period as that employed in the test. The current in each case was calculated from the resistance and potential difference, and the results gave no appreciable difference in the constant for continuous and alternating currents.

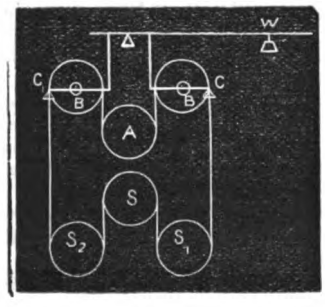


FIG. 1.

The following tables show at once the order in which the tests were carried out and the results:—

HORSE-POWER ABSORBED AT VARYING E.M.F.S.

	E.M.F.		
	Dynamo.	Exciter.	H.-P.
Horse-power for exciter, field not made	0	0	·34
„ „ field made	0	110	·75
„ „ dynamo alone	0	0	2·73
„ „ dynamo and exciter	0	0	3·01
„ „ „ „	0	107	3·51
„ „ „ „	1376	124	12 5
„ „ „ „	1168	104	10·1
„ „ „ „	1099	105	9 60
„ „ „ „	1040	105	9·0
„ „ primaries of converters on...	1216	105	12·0
„ „ „ „	1171	104	11 8
„ „ „ „	1107	104	11·12
„ „ „ „	1048	104	10·64

TABLE OF EFFICIENCY AT VARYING LOADS.

Approximate load.	Exciter.		Dynamo primary.		Converters.		Horse-power in lamp circuit.	Mechanical horse-power.	Loss in horse-power.	Efficiency.
	E.M.F.	Current.	E.M.F.	Current.	E.M.F.	Current.				
¼	105	9·4	1107	10·0	49·5	153·9	10·21	21·83	11·62	46·8%
½	104	10·5	1107	18·9	49·6	338·4	22·50	34·4	11·90	65·4%
¾	101	11·0	1113	28·6	50·0	520·7	34·9	48·0	13·1	72·7%
Full	112	11·5	1125	38·1	50·9	739·8	50·48	64·44	13·96	78·3%

EFFICIENCY OF CONVERTERS.

No. 8. 40-light Converter.

No. of lamps.	Volts.	Watts in secondary.	Loss in watts.	Loss in iron.	Efficiency.
40	50·0	2001	109	...	94·8
0	50·9	0	84	84	...

No. 4. 20-light Converter.

No. of lamps.	Volts.	Watts in secondary.	Loss in watts in secondary.	Loss in iron watts.	Efficiency.
20	43·8	952	106·0	95·2	90·0%
15	52·2	817	114·8	108·9	87·6%
10	50·3	506	101·7	99·2	83·3%
5	51·44	264	109·4	108·7	70·7%
0	52·3	0	110·5	110·5	0· %

The efficiency of the converters was measured by placing them in a metal calorimeter, between the double walls of which water was allowed to flow. The temperatures of exit and entrance were observed, as well as the weight of water which passed through; at the same time the current and potential difference in the secondary circuit of the converter were measured. A separate observation gave the radiation, which was of course allowed for, although it was made as small as possible. A number of converters were experimented on, but I give but two of them, a 40-lighter, such as was used in the tests, and a 20-light converter which was very carefully tested by two of my students, Messrs. Bliss and McKeen. In the latter case the observations were made at slightly different potential differences, and the results show that the loss in the iron varies as we would expect it to vary, that is, very nearly as the square of the voltage. The variation will not be exact, as the losses due to the reversal of magnetism do not vary quite as fast as the square of the induction.

I would like here to call attention to the fact that in an excellent Paper read before this Institute, Prof. Ryan, of Cornell, found that the losses in the iron of a 10-light converter decreased greatly as the load increased. This was accounted for by the fact that there was a jar (evidenced by the singing of the converter) at the higher loads, due to the attractions of the secondary and primary coils. While it is true that the losses in the cores of very small converters are not exactly constant, yet they are nearly so, and a large part of the decrease found by Prof. Ryan is due to the voltage being greater at the low than at the high loads.

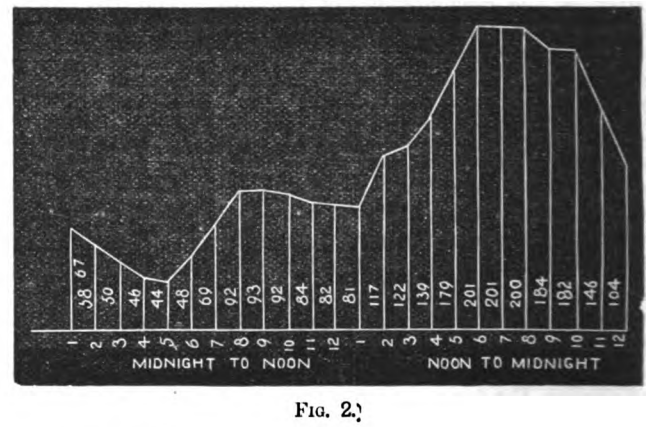


FIG. 2.

Looking now at the figures given in the tables, we are struck by two things: the very large amount of power absorbed in the core of the armature, and the very small loss in the converters on open circuit. The dynamo losses due to reversals of magnetism and eddy currents at the E.M.F. used in the test are no less than 6 horse-power, while the energy due to reversal of magnetism and eddy currents in the 16 converters is only 1·6 horse-power. Another rather striking thing is the almost constant ratio of primary and secondary currents over a considerable range. The maximum efficiency is about 78 per cent. It would seem that the losses could be divided into a constant part and one varying with the current; but this is not true with the older style and smaller converters of the Westinghouse Company.

Suppose we have a plant such as is described above, and use it for commercial lighting. Taking data from one of the local companies employed in supplying incandescent lights on this system, we have, for two 2,500-light dynamos, the following outfit of converters:—

Size of converters.	Capacity.	Number in use.	Total lamps.
No. 1	5 16 candle-power lamps	44	220
No. 2	10 „ „	61	610
No. 4	20 „ „	43	860
No. 6	30 „ „	49	1,470
No. 8	40 „ „	64	2,560
	Total lamp capacity		5,720
	Number of lamps supplied		4,557

Digitized by Google

I understand that the converters being added are of the larger sizes. The efficiency of the 30-light converters does not differ greatly from that of the 40-lighters. The accompanying Fig. 2 is a load diagram of this plant, selected from a number of diagrams as giving a fair average curve. If we have our dynamo working to its full capacity, then from the above data we would have a converter capacity of 23 40-light converters.

If, as in our test plant, these converters are 40-lighters, or 30-lighters—for the efficiency of these two sizes is about the same—we should have a mean loss in our plant of, say, 10 horse-power in our dynamos ($9{\cdot}6 + C^2 R$), and in the converters about 3 horse-power ($2{\cdot}3 + C^2 R$); or all together about 13 horse-power. From the above table we will have 750 lamps supplied, and taking the data from the load curve the average load would be in the neighbourhood of 1,300. This corresponds to about 20 horse-power, and the efficiency of the plant for 24 hours would be $\frac{20}{33} = 61$ per cent., minus the percentage of loss on the lines. This, in a properly installed system, should not average 2 per cent. so that the final efficiency would be 59 per cent. A continuous-current dynamo supplying the same outfit of lamps, with a maximum loss in the mains of, say, 15 per cent., would have a greater average efficiency. But I wish to point out that the maximum efficiency of the two plants would be about the same, so that they would require the same capacity of station outfit, boilers, engines, dynamos, &c. When more than one dynamo is provided, the efficiency is increased by using only one of them during the times of minimum supply, and always working, as far as possible, only a little below the maximum capacity of the machines.

Let us consider these results in view of the present condition of incandescent light distribution in the United States. I take it that what may be called domestic electric lighting is largely a matter of the future—it is certainly not a matter of the present. The majority—the great majority—of the lights in use are in shops, saloons, theatres, offices, &c. Most of the lights wired are in use at one time or another during the 24 hours, and the proportion of energy supplied to the total capacity of the lamps connected is much greater than it would be in the case of house lighting, where, on the average, only a small fraction of the possible lamp-hours are actually in use. Under these circumstances the scheme of alternate-current distribution is very different from what it will be when the attempt is made to supply an entire city with light, as they are attempting to supply London at the present time. If the object of the lighting company is to supply the demand that exists at present, then a system employing a number of small converters is preferable. Such a system is flexible and can be installed with a minimum expense for the more or less scattered demand which is presented in even the most closely-settled town. I take it that this is the great difference between the alternating and direct systems as at present installed in this country. The former skims over an extended district, taking advantage of its great flexibility to absorb any business which can be got; while the latter settles itself in a densely-built centre, instals a larger plant than is primarily demanded, and works up a business within the limits of economical distribution. Therefore, it is hardly right to compare the present systems of direct and alternating supply, as the latter has not been reduced to a point where entire districts are to be supplied.

To show the disadvantage of the present system for domestic supply, suppose we have an ordinary house such as one of us would live in; it would be necessary to have a converter of at least 20-light capacity. The constant loss is, say, 100 watts; so, leaving out the $C^2 R$ loss, we would have a total loss in 24 hours of $\frac{2400}{750}$, or about 3 horse-power hours, corresponding to, say, 45 lamp-hours. Taking my own experience, the actual number of lamp-hours used is about 30 lamp-hours during 24 hours, so the efficiency of the converter would be something like $\frac{30}{75} = 40$ per cent. It is evident that unless the losses in converters can be greatly decreased, a house-to-house distribution with a converter in each house would hardly pay.

It would seem, then, that if gas is to be really displaced, and serious competition with it is to be attempted, a different system of distribution must be worked out. We must replace the numerous small converters with one large converter supplying a comparatively extended district. If an extended secondary network is employed, some of the converters may be disconnected from the mains at the turn of minimum demand.

The authors then discuss how the increase in the capacity of converters will modify their design, and come to the conclusion that the efficiency of the larger converters will be greater than the smaller ones of the same design and working at the same temperature, but the output per pound of metal will be less. Referring, then, to Mr. Swinburne's British Association Paper on the "Design of Converters," the authors remark that they suppose most of those who have read it have been struck by the fact that almost all of the converter dimensions given by him are impracticable, either on account of the disproportionate heating of the larger sizes or the excessive fall of potential in the secondary. In increasing the size of dynamos we usually increase the output per pound weight, but there is the vital distinction between dynamos and converters that losses occur through the entire mass of the latter, and as we increase the volume we increase the losses in the same proportion. In the dynamo, on the contrary, there are practically no losses in the heaviest part of the apparatus, *i.e.*, the field-magnets. As a result, while we gain in efficiency in the larger sizes of converters, yet we must decrease either our induction or the rate of reversal, and the output per pound is not increased.

BOOKS, &c., RECEIVED.

"Journal of the Institution of Electrical Engineers." Vol. XIX., No. 85. (London: E. and F. N. Spon.)

"Der Betrieb und die Schaltungen der Elektrischen Telegraphen." Vol. I. By Dr. Karl Edward Letsche. (Halle: Wilhelm Knapp.)

"Berechnung Elektrischer Messungen." By W. R. P. Hobbs. Translated from the English by O. Kietzer. (Halle: Wilhelm Knapp.)

"Everybody's Pocket Cyclopædia." (London: Saxon and Co.)

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-night) FRIDAY, April 18th.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "Welding by Electricity." By Sir FREDERICK BRAMWELL, Bart., F.R.S.

SATURDAY, April 19th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture: "Colour and its Chemical Action." By Captain W. DE W. ABNEY, R.E., F.R.S.

MONDAY, April 21st.

LONDON CHAMBER OF COMMERCE.

4 p.m. Electrical Trade Section. Annual General Meeting.

TUESDAY, April 22nd.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture: "The Place of Oxford University in English History." By the Hon. GEORGE C. BRODRICK, D.C.L.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be discussed: "The Application of Electricity to Welding, Stamping, and other Cognate Purposes." By Sir FREDERICK BRAMWELL, Bart., F.R.S.

SOCIETY OF ARTS.

5 p.m. Foreign and Colonial Section. "The Danube and its Trade." By Sir JOHN STOKES, K.C.B.

ROYAL VICTORIA HALL.

8:30 p.m. Penny Science Lecture: "Old London." By Rev. BLOMFIELD JACKSON.

WEDNESDAY, April 23rd.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. "Coal in the South-East of England." By WILLIAM WHITAKER, F.R.S.

THURSDAY, April 24th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture: "The Heat of the Moon and Stars." By Prof. C. V. BOYS, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be read: "On a Lightning Guard for Telegraph Purposes, and on the Protection of Cables from Lightning." By Dr. OLIVER LODGE, F.R.S.

FRIDAY, April 25th.

INSTITUTION OF CIVIL ENGINEERS.

7:30 p.m. Students' Meeting. Paper to be read: "Some Applications of Electricity in Engineering Workshops." By C. FREWEN JENKIN, B.A.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "The Shapes of Leaves and Cotyledons." By the Right Hon. Sir JOHN LUBBOCK, Bart., M.P.

SATURDAY, April 26th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture: "Colour and its Chemical Action." By Captain W. de W. ABNEY, R.E., F.R.S.

*** Particulars of meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.

Digitized by Google

The Electrician.

Published every Friday. Price Fourpence; Post Free, Fourpence Halfpenny.
Editorial, Publishing and Printing Offices:

SALISBURY COURT, FLEET ST., LONDON, E.C.

Telephone No. 2714. Telegrams: "ELECTRICIAN NEWSPAPER, LONDON."

All Communications to be addressed to "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN."

All letters intended for insertion in "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. Subscribers should receive their copies by the first post on Friday morning.*

"THE ELECTRICIAN" *is on sale at the railway bookstalls throughout the United Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices as above.*

SPECIAL NOTICE.

Owing to the increase in the number of pages of "THE ELECTRICIAN," in order to partly cover the increased postage, we have been compelled to revise the rates for Foreign Subscriptions, which are now as follows:—

	3 months.	6 months.	12 months
For Foreign Parts and Colonies:—	s. d.	s. d.	s. d.
Within Postal Union	6 6	12 6	24 0
Aden, Borneo, Ceylon, China, India, Japan, Java Labuan Mosambique, New Caledonia, Persia, Philippine Islands, Siam, Transvaal, and Zanzibar	7 6	14 6	28 0
The rates for the United Kingdom remain as follows:—	5 0	10 0	19 6

TO ADVERTISERS.

"THE ELECTRICIAN" *offers exceptional advantages to Advertisers.* **It has the largest circulation of any English Electrical paper, and circulates all over the World.**

Particulars relating to Advertisements will be promptly forwarded on application to the office.

TRADE ADVERTISEMENTS *intended for the current issue must be handed in not later than First Post on Thursday morning.*

SMALL PREPAID ADVERTISEMENTS *(for Rates see page xv.) are accepted up to 4:30 p.m. on Thursday.*

TECHNICAL PRINTING.

"THE ELECTRICIAN" PRINTING AND PUBLISHING COMPANY (LIMITED) *beg to inform Electricians, Electric Light Engineers, &c., that they make a specialty of Technical Printing, and have a Staff thoroughly acquainted with Electro-Technology. They can, therefore, promise Accuracy and Despatch in the Printing of Electrical Catalogues and Electro-Technical Literature generally.*

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.

Royal 8vo, 5s., postage extra.

Early in each year is issued "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK. *The* DIRECTORY *was established in 1883, and the 1889 Edition consisted of more than 600 pages of printed matter. The names and addresses of all persons engaged in the Electrical Industries may be relied upon as accurate. Useful Tables and Electrical Formulæ, and information specially compiled for this work are given, together with popularly-written Biographical Notices of the leading Electricians, Electrical Engineers, &c., accompanied in many cases by Portraits.*

The issue for 1890, which is still further enlarged and improved (making 850 pages), is NOW READY. Orders should be forwarded at once to the Publishing Offices, Salisbury-court, Fleet-street, London, E.C.

CONTENTS OF THE CURRENT NUMBER.

NOTES 587
Magnetism in Iron and other Metals.—XVI. By Prof. J. A. Ewing, F.R.S. Illustrated. Continued 591
The Progress of the Electric Light in Australia. By E. J. Erskine 592
The Lighting of Chelmsford ... 593
Some Tests on the Efficiency of Alternating-Current Apparatus. By Dr. Louis Duncan and Mr. W. F. C. Hasson. Illustrated 593
Books Received 595
Meetings of Scientific Societies. 595
LOCAL AUTHORITIES AND ELECTRIC LIGHTING ORDERS 596
The Institution of Electrical Engineers—
"On Signalling Across Rivers in India." Illustrated ... 597
"The Diathermacy of Air in Relation to the Efficiency of Incandescent Lamps ... 600
On Electric Motors in General Railway Work. By Dr. L. Bell Concluded 600
Parliamentary Intelligence 601
American Notes 603
CORRESPONDENCE—
Alternating *v.* Continuous Currents in Relation to the Human Body.—Henry M. Sayers and W. O. Bailey 604
Dynamo and Motor Design.—W. B. Sayers 604
The Development of Electric Traction.—Gerald St. John Day 605
Cardew Earthing Device. Ill. 605
Trade Notes and Notices 606
COMPANIES' MEETINGS, &c.—
The Submarine Telegraph Company (Limited) 606
Montevidean and Brazilian Telegraph Company (Ltd.) 607
Bedford Electric Lighting Company (Limited) 607
The Continental Metropolitan Tramways Company (Ltd.) 607
Eastern Extension, Australasia and China Telegraph Company (Limited) 608
The Indo-European Telegraph Company (Limited) 609
Reuter's Telegram Company (Limited) 609
City Notes, &c. 609
Companies' Share List 610

"THE ELECTRICAL WORLD" OF NEW YORK.

"THE ELECTRICAL WORLD" OF NEW YORK *can be obtained from* "THE ELECTRICIAN" *Office, Salisbury-court, Fleet-street, London, E.C. The Rate of Subscription (payable in advance), is* **£1 1s.** *per annum. Single Copies* **price 6d. each; post free, 8d.**

"ANALES DE LA ELECTRICIDAD" OF BARCELONA.

Published fortnightly. Annual Subscription (Postal Union) Fifteen Pesetas. Single Copies **6d.; post free 7d.** *A Specimen Copy will be forwarded and subscriptions received by* "THE ELECTRICIAN" PRINTING AND PUBLISHING COMPANY, Ltd.

"THE ELECTRICIAN" PRINTING AND PUBLISHING COMPANY, Ltd., *are Agents in Great Britain for all the above well-known journals, and particulars as to Advertisements will be supplied on application to* "THE PUBLISHER," *1, 2, and 3, Salisbury Court, Fleet Street, E.C.*

LOCAL AUTHORITIES AND ELECTRIC LIGHTING ORDERS.

The Association of Municipal Corporations has undoubtedly scored a great triumph over the Board of Trade in procuring for Local Authorities that alteration of the "Model Order" which they have long been striving to bring about. In the earlier stages of the negotiations the Secretary of the Board was firm in his refusal to go beyond conceding the transfer of powers granted under the Order; but apparently, on an appeal to the President, the whole of the demands have been acceded to, a transfer of liabilities as well as powers being rendered permissible if the corporations in possession of the Order desire to part with these privileges. The immediate effect of this act of grace on the part of the Board is to still further accentuate the favourable position which Local Authorities hold in respect to electric lighting enterprise. But the ultimate effect will be far greater, and, to our thinking, will practically repeal some of the more important provisions of the Act itself on which the Board of Trade is supposed to be working. No doubt the Board is acting on competent legal advice in this matter; but if so, it only shows how elastic an Act of Parliament may be deemed to be when its precise stipulations are capable of being overridden or made nugatory by the Department which has to

Digitized by Google

administer it. The Local Authorities can now, it would appear, secure an Electric Lighting Order nominally for themselves and on the terms prescribed by the Acts of 1882 and 1888, but can immediately dispose of their acquisition on any terms they please to a private purchaser. In other words, all future electric lighting operations, wherever the Local Authorities have intervened, will be carried on, not under the Act of Parliament, but under the conditions imposed by an irresponsible intermediary.

We are left in no doubt as to the onerous character which these conditions will assume; for already, in a considerable number of cases, the consent of a Local Authority to waive its opposition to the granting of a Provisional Order has been given to private undertakers only after altering in every particular the terms and periods of purchase specifically laid down in the statute. It is certain that, in transferring the powers and liabilities obtained on their own application, the conditions of transfer will be not less advantageous to the Local Authorities. This, indeed, is the course recommended by the writer of the article headed "Local Authorities and Electric Lighting," in *The Times* of last Saturday, the concluding words of which invite them to "stipulate for terms of purchase at an earlier period than that allowed by the statute, and for conditions less ambiguous than those contained in the purchase clause of the Electric Lighting Act of 1888." By less ambiguous, the writer clearly means less profitable to the vendor; for, although there is some ambiguity in the language of corresponding Acts relating to tramway lines, there exists no doubt as to the meaning of the purchase clause in the Electric Lighting Act when read by the light of the debates which took place upon it, or, indeed, by the light of the words themselves, which exclude all idea of buying at anything but the then fair market value.

On the article just referred to, *The Times* had a leader of the same date, recapitulating the facts supplied by its well-informed correspondent, but declining to follow up his advice in the same confident and one-sided spirit. The operations of municipalities as commercial contractors are already carried on to an enormous extent, and are not always above the suspicion of abuse and jobbery. To extend these operations—as this latest concession in regard to Electric Lighting will greatly tend to do—cannot be contemplated with feelings of unmixed satisfaction. It is open to grave question, at least, as *The Times* points out, whether the functions of these municipal bodies should be so greatly enlarged, or that they should be allowed more and more to interfere in settling the terms of leases of profitable concerns with which they have no prescriptive right to meddle. There is nothing in the natural order of things requiring municipal bodies to become manufacturers and purveyors of commodities where private enterprise can do the business as well, or better; and certainly nothing to justify their being put in possession of advantages not enjoyed in ordinary commercial life. One of the most elementary stipulations attached to a statute conferring special privileges is that they shall not be bartered away immediately for a profitable consideration. Yet this is a condition which has been entirely waived in the case of Local Authorities possessing Electric Lighting Orders; and we should like to know the reason why. It may be possible to find a reason for municipal trading in the Socialistic teachings of the day; but it is straining Socialism very far when the law of the land is set aside or evaded in order to save the local community all the risks, and secure to it all the profits, of an enterprise which it has not the courage to take upon itself.

For this, in fact, is what we have come to if the writer in *The Times* has correctly interpreted the effect of the Board of Trade's arrangement with the Association of Municipal Corporations. They are not prepared to embark in the experiment of Electric Lighting on their own account for fear it should fail. But in case it should succeed in private hands—not otherwise—one of the conditions of the experiment is to be that the business shall then become the property of the Local Authority. It is a striking proof of the confidence that has grown up latterly in electric lighting industry that anybody can be found to accede to such unreasonable demands. But so it is; and we fear it is little use calling upon electric lighting undertakers to combine as a body for the purpose of making a stand in their own defence. The Local Authorities evidently count upon the competitive disunion of their clients, and *The Times'* correspondent confidently reckons on there being always plenty of applicants ready to take the rights and liabilities off the hands of the Local Authorities. We are told, therefore, that there will be another great rush for Provisional Orders, this time by municipalities who will dispose of them advantageously. It ought to be the business of electric lighting undertakers to see that this prediction is not fulfilled, and that the Local Authorities shall either assign the work to a private company on equitable terms, or be made to do it themselves. It is true they may transfer their liabilities to some one else; but not even the Board of Trade has yet ventured to say that their liabilities will cease if they cannot be transferred.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

ON SIGNALLING ACROSS RIVERS IN INDIA.*

BY W. F. MELHUISH.

Rivers which intercept lines of telegraph are crossed either by means of ordinary wires supported on masts of wood or iron, or by means of cables; and experience has not only shown that the former method is preferable, but also that the life of a river cable in India is a very precarious one. However, in the case of rivers of greater breadth than can be spanned, cables must be employed. The causes which affect river cables will be only briefly noted here; they are—

1. Deterioration of the shore ends by changes of temperature affecting the dielectric.
2. Damage from anchors of ships and steamers.
3. Alteration of the channels and cutting away of the banks.
4. Damage to the dielectric by lightning.
5. Imperfectly made joints.
6. Attacks by white ants and rats.

It not unfrequently happens that a river cable fails entirely, or becomes imperfect at a time when, owing to the force of the stream, a new cable cannot be immediately laid, or when there is no ready-made cable available, or when a considerable period must elapse before the new cable can reach the river. To provide for these contingencies, attempts have from time to time been made in India to signal across rivers without cables, and it may be of general interest to know what has been done in this respect by myself and others.

Three different methods appear to have been discussed and attempted, viz:—

1. Signalling through an imperfectly insulated wire.
2. Signalling through an ordinary bare wire.
3. Signalling without any metallic conductor.

More than thirty years ago, Mr. Van Rees, between Portsmouth and Gosport, in salt water, and subsequently Dr. Gintl in fresh water, tried to signal without a wire; but the result was in both cases a failure, and was supposed to be so because the resistance through the earth between the two groups of earth-plates on the same side of the river was too small as compared with the resistance between the two groups across the river. For success it was assumed to be necessary to bury the two groups of earth-plates on each bank from a quarter to a half-mile apart, and to connect them by thick insulated wire. In India, about the year 1858, Mr. Blissett acted on this plan, and obtained a fair measure of success by employing land lines of considerable length on either bank of the river. In the year 1876 the late Mr. Schwendler made some

* Paper read before the Institution on April 10, 1890.

Digitized by Google

experiments across the river Hooghly at Barrackpore, near Calcutta; and subsequently, during September, 1879, the late Mr. W. P. Johnston, electrician, made the following experiments :—

On the 9th September, 1879, he attempted to signal across a broad canal *without* any metallic conductor. Fig. 1 is a diagram of the connections, &c.

E = 10 Bunsen's cells joined in series ;

R, a needle instrument having a resistance of 1 ohm, also a bell telephone having a resistance of 4·25 ohms ;

W = a resistance of 1 ohm, e = four Minotto cells joined parallel } This arrangement exactly balanced the natural current through the receiving instrument.

A, B, C, D were copper-plates, 8ft. 8in. by 4ft. 4in. by 1-16th inch thick, buried on the banks of the canal. B was buried 15 yards distant from A, and D was buried the same distance from C.

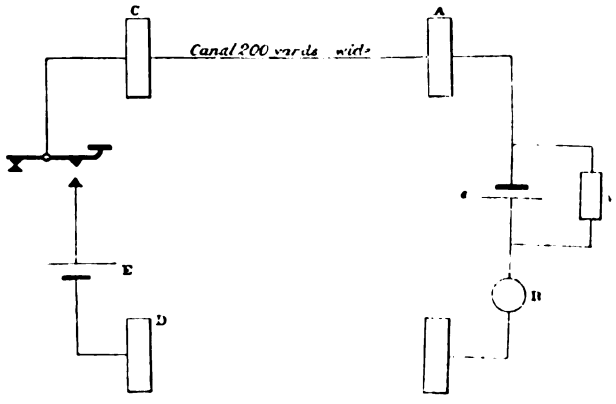


Fig. 1.

All the plates were buried parallel to the canal. The resistance between A and B was 7·5 ohms, and that between C and D was the same. Under these conditions both the needle instrument and the telephone (used, of course, as a telegraph, and not as a speaking instrument) gave distinct and readable signals.

After several days of experiment with the second method (Fig. 2), using a single bare 600lb. per mile galvanised wire, the following results were obtained :—

E = 15 Bunsen's cells in series ;

R, a polarised Siemens relay of 21 ohms resistance ;

e = 4 Minottos joined parallel
W = 10 ohms } Balanced the natural current.

The measured resistance of the circuit was + 2 – 20 ohms. The signals received were quite regular and safe ; the tongue of a relay worked an ordinary sounder in local circuit, and no difficulty was experienced in balancing the natural current through the relay. To balance this natural current is a most important element of success in this mode of telegraphing.

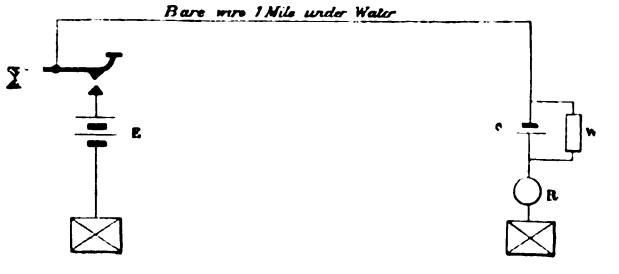


Fig. 2.

Subsequently three miles of the same wire were laid along the canal, the wire having previously been passed through a mixture of pitch and tar, and for the hour the instruments were in circuit perfect signals were received.

The experiment with the bare wire for a distance of one and a-half miles was not successful ; and as it appeared that in order to obtain signals the battery power would have to be increased as the square of the distance, the limit through which signals can be received on bare wire under water is very soon reached.

During May, June, and July of the year 1888, Mr. Johnston made a long series of trials across the canal and the river Hooghly, and the subsequent measurements and experiments led him to come to the following conclusions, viz. :—

That up to 1½ miles it is perfectly easy and practicable to signal through a bare wire under water.

That for greater distances, judging from experiments, it is not possible to signal in this manner.

In April, 1889, Mr. W. P. Johnston died, and the duties of electrician were entrusted to me. Having studied the recorded labours of my predecessor, and learnt that by pursuing the same lines it was hopeless to expect to be able to signal through a bare wire across a river that had a greater breadth than one and a-half miles, I resolved to change the class of signalling apparatus and to continue the experiment. Discarding continuous steady currents and polarised receiving relays, I adopted Cardew's vibrating sounder, and the sequel will show how completely successful the change of instruments proved to be. I began from the beginning, and tried to signal across a water-way without a metallic conductor by laying down two earth-plates on each of its opposite banks. Readable signals having been exchanged, the distance separating each pair of plates was varied, with the view of ascertaining how close the plates might be brought together, the signals remaining still readable. Readable signals were exchanged when the distance separating the plates was equal to the breadth of the river, reading becoming more difficult as the plates were made to approach each other, and clearer and more distinct as the distance between the plates was made to exceed the breadth of the river. I learnt from these experiments that in order to obtain signals of sufficient distinctness for the practical purpose of transmitting messages, it would be necessary to construct a line on each bank of a river much longer than the breadth of the river ; and as the rivers along the coasts in India are extremely wide, I became impressed with the impracticable character of such an undertaking, and decided to strike out a new line. This new line was the laying of two bare uninsulated iron wires across the water-way parallel to each other, and separated by a certain distance, the ends on each bank being looped together by means of an insulated conductor. Hence, though

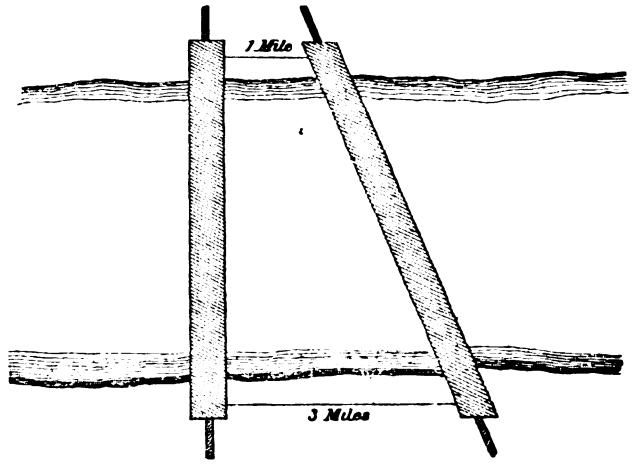


Fig. 3.

much of the circuit was laid under water, it was nevertheless a continuous metallic circuit. Beginning first with a complete square, by laying the wires as many yards apart as the river was wide signals were instantly exchanged that were incomparably louder than those that were exchanged when the same area was bounded by four earth-plates. The length of each of the two wires under water was next gradually increased to 740 yards, and the distance separating them gradually diminished to 35 yards, the strength of the signals diminishing proportionately, and ceasing to be readable when the wires were further prolonged. The conclusion arrived at from these experiments was that, for the practical and useful purpose of signalling messages across a broad river, in the absence of an insulated cable a complete metallic circuit was at least desirable. Acting on this conclusion, it was sought to apply it practically, and the following experiment was carried out :—At a distance of 15 miles west of Calcutta a cable is laid across the river Hooghly, which at this point is 900 yards wide. The iron guards of this cable were employed to form one of the metallic conductors, and at a distance of 450 yards down stream a single wire, weighing 900lb. per mile, was laid across the river to form the second metallic conductor, insulated land lines having been run up to loop the two parallel conductors together. The experiment was quite a success, the signals being readable without difficulty.

An experiment was next made on a defective cable across Channel Creek, at the mouth of the river Hooghly. This creek is crossed by two cables laid in the same trench ; the length of each is 3,000 yards, and one of them had been completely parted by a steamer's anchor. Several attempts were made to signal across by using the guards of one of the cables as a lead, and the guards of the other as a

Digitized by Google

return wire, but the efforts proved unsuccessful owing to the too close proximity of the cables. For every cable crossing there is a certain minimum distance apart at which the cables must be laid, and if this minimum, which depends on the breadth of the river, be exceeded, an absolute short-circuit becomes established. But although it was not possible here to signal through the iron guards, the most perfect signals were passed through the two conductors when they were formed into a loop, notwithstanding the fact that the two ends of the broken conductor were exposed in the sea and were lying at a considerable distance apart. An experiment was now made in order to ascertain what chance there might be in the future of signalling across the two conductors, should an accident occur to the good cable. Accordingly the conductor of the good cable was disconnected in the cable-house from the signalling apparatus and placed upon the ground, when the signals, though greatly diminished in volume, still continued to be distinctly readable. It may, therefore, be reasonably inferred that should the good cable suffer a similar fate to that of the defective cable, communication can, by means of Cardew's sounders, be kept up by looping the ruptured conductors until arrangements can be made for laying a new cable or repairing the defective ones.

It will probably suffice if from the succeeding experiments that were made to test the efficiency of the vibrating sounder in the case of conductors breaking down at river crossings I select the following three, exhibiting as they do progressive evidence of the value of this signalling instrument, and culminating in establishing it beyond dispute as one that can be relied on for carrying on independent communication through the iron guards of cables while the insulated copper conductors form parts of other circuits.

Experiment No. 1.—The local line from the Central Office, Calcutta, to Garden Reach is about four miles in length, and at about midway the wire spans a small river. Vibrating sounders having been put in circuit at each end of this line, the wire where it crosses the river was taken down and laid along the bed of the water-way. Signals were loud and clear at both ends.

From the success of this experiment it may be inferred that on any ordinary line, should the wire from accidental causes come off the insulator and make earth by touching the bracket, standard, or ground, or should the wire break and both ends of it be lying on the ground or in a water-course, communication could still be maintained by means of the vibrating sounders.

Experiment No. 2.—The line wire which connects the town of Chandernagore with Barrackpore is about 10½ miles long, 900 yards of which consists of a cable laid across the river Hooghly. Vibrating sounders having been joined up in the telegraph offices at Barrackpore and Chandernagore, the insulated conductor of the cable was thrown out of circuit, and the line wire on each side of the river was joined to the iron guards of the cable; thus for a length of half a mile out of 10½ miles the conductor was wholly under water, yet it was found quite feasible to transmit messages between the two offices.

From the success of this experiment it may be reasonably inferred that in the case of certain cable crossings, where the rivers are not too wide, should the copper conductor of the cable make dead earth or become insulated by parting, communication could still be kept up between the two offices on either side.

Experiment No. 3.—The terminus of the Northern Bengal State Railway at Sara is separated from that of the Eastern Bengal State Railway at Damukdia by the river Ganges. The opposite banks of the river in this locality are connected by two independent cable crossings. The length of one of these crossings is 1 mile 610 yards, and of the other 4 miles. The distance which separates the two cable houses on the Damukdia side is 3 miles 1,584 yards, and on the Sara side the cable houses are only 1 mile 211 yards apart, giving a mean lateral distance in alignment of 2 miles 880 yards. The two cable houses on each bank of the river have an insulated connecting land line. The two cable crossings and the connecting land lines form an irregular metallic circuit somewhat resembling that given in Fig. 3.

The connecting land lines having been joined to the iron guards of the cables, two vibrating sounders were placed in circuit, one on each side of the river, when signals so strong were transmitted across that it was not difficult to read them at a distance of 6ft. away from the receiving telephone.

From the marked success of this experiment it may be inferred that at all river cable crossings where the cables are laid in separate alignments (and the farther apart the better), should the cables become interrupted, communication may still be maintained from bank to bank by using vibrating sounders, thus avoiding the delay, inconvenience, and cost of a boat service.

It should also be remembered in the case of such a parallel cable crossing, that besides the circuits afforded by the copper conductors, when these are in working order, there is always an additional local circuit available by means of the iron guards between the opposite cable houses, and that this circuit could be used by means of the vibrating sounder as a talking circuit, in cases of necessity, without interrupting through working on either of the cables.

Each of these three experiments may properly be described as a delicate experiment. With so much of the conductor under water, the quantity of current which reaches the receiving telephone is so infinitesimal that signals could not be successfully transmitted if the vibrator were joined up in the ordinary manner. It is desirable in circumstances similar to these to reduce all the resistance external to the actual connecting lines to as small a quantity as possible, and therefore, when messages are being transmitted, the telephone at the sending end should be removed from the circuit, as also should the vibrator from the receiving end. To effect this twofold purpose a special form of signalling key (designed by the writer) is requisite, and should be used. The action of this key, together with the complete set of connections for a parallel cable crossing, is shown in Fig. 4.

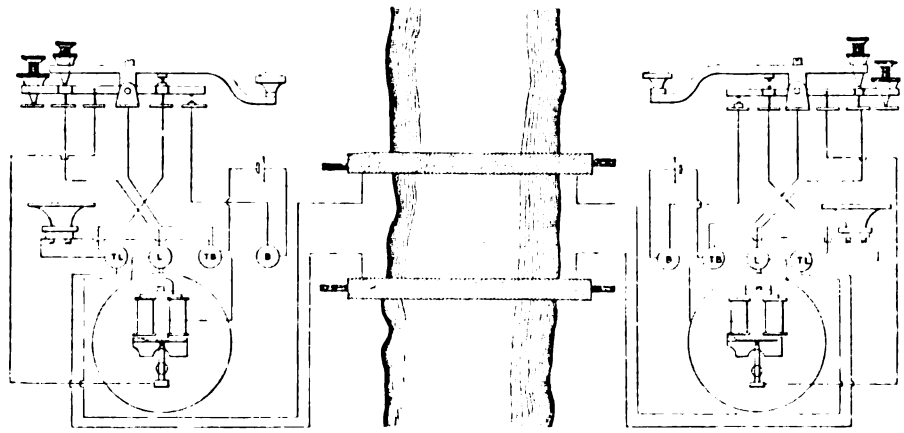


Fig. 4.

DISCUSSION (Authorised Abstract).

Major CARDEW said he was glad to hear that his vibrating sounder had been so serviceable in the experiments described in the Paper. He did not consider himself entitled to much credit for his sounder, as similar instruments had been used by others before him; it was rather the system he described before the Society in 1886 that was of importance. This system had been found extremely useful in cases of emergency such as occurred when the last heavy snowstorm broke down nearly all the wires in the metropolis. The idea of obtaining communication by bare wires as mentioned by Mr. Melhuish's Paper seemed to him good, and he thought copper wires would be better than iron ones. In addition to the armour of cables being used as a local talking circuit, it was easy, he said, by using the vibrator, telephone, and small condensers, to talk along the main conductor without interfering with the through traffic. Referring to the special signalling key shown in Fig. 4, he said that in his 1886 Paper he had given an arrangement for producing the same effect in what he considered a more practical way.

General WEBBER considered the questions dealt with in the Paper of considerable importance in practical telegraphy. The life of river cables in India was, he said, very uncertain, due in some measure to the great variations of depth which the rivers undergo; in some cases the depth changes from five to sixty feet in a single season. It must not be supposed, however, that cables could not be used successfully in rivers, for during the Franco-German War a six-wire cable was laid from Bromley to London

Digitized by Google

along the bed of a small stream in order to complete the communication with France *viâ* Beachy Head. This worked satisfactorily for six months. Another instance occurred at Wady Halfa, in the Soudan, where a piece of ordinary field line was laid across the Nile and served to transmit messages until an armoured cable was obtained. This latter cable was very successful. Referring to the use of Cardew's sounders for signalling without wires, he said the idea was not new, for they were employed some years ago in signalling across the Solent between Hurst Castle and Yarmouth. It was also found possible to communicate between Portsmouth and Newport, a distance of about 35 miles, *viâ* Hurst Castle and Yarmouth, although no metallic circuit existed between the two latter places, which are six or seven miles apart. The vibrator and telephone were also found very useful in Egypt for signalling through a badly insulated-wire to a lineman who had gone to search for the fault.

Mr. CHARLES BRIGHT said the utility and importance of Mr. Melhuish's experiments were not confined to communicating across rivers, but had a direct bearing on the difficulties existing in signalling between lightships and the shore. Mr. Willoughby Smith, he understood, had been successful in signalling to boats without communicating wires (*The Electrician*, November 2, 1888, p. 833), but Mr. Melhuish seemed to have failed in similar experiments. He was not aware whether Mr. Smith's experiments had been proceeded with.

Mr. GRANVILLE, referring to the method of signalling across rivers by uninsulated cables and insulated land lines, said he had recently found a patent, dated 1838, in which the method was described, and he believed it was tried between England and Ireland, but without success. Mr. Willoughby Smith's experiments were quite satisfactory, and they had been discontinued partly because the Telegraph Construction and Maintenance Company had overcome the difficulties in signalling to lightships in another way, and partly owing to Mr. Smith's ill-health.

Mr. WYLES was not surprised at the success which had attended Mr. Melhuish's experiments with Cardew's vibrating sounders. Some years ago, when he was working with them, the question was not what you could work through, but what you could not work through. Major Cardew's key was, in his opinion, simpler than the one devised by Mr. Melhuish.

Mr. MORDEY said Mr. Preece had informed him that the dynamos at Deptford affected the telephones in Paris. If this were so, signalling across seas was already accomplished.

THE DIATHERMANCY OF AIR IN RELATION TO THE EFFICIENCY OF INCANDESCENT LAMPS.*

BY F. HIGGINS.

It is occasionally useful to know something of thu state of the vacuum in incandescent lamps without injuring them by perforating the bulb with electric discharges. The property which air possesses of transmitting radiant heat in proportion to its density, affords a means for obtaining this information. I have not seen any mention of this property in works on the subject which I have consulted, and do not know whether my results agree with others which may have been obtained.

In order to make some comparative tests, I obtained, through the kindness of Major Flood Page, a number of lamp-bulbs fitted with similar filaments of platinum iridium, as nearly as possible alike in length. Some of these bulbs were exhausted to the highest possible degree, some left open to the air, and others exhausted to a pressure equal to 1-10th inch of mercury. With a sensitive thermoscope the different qualifications of the three descriptions can be made apparent. The lamps of each class being very similar in their behaviour, it is only necessary to give the results obtained with one of each type. The highest possible exhaustion is that which is supposed to be the condition of the electric lighting bulbs; the 1-10th inch gives a vacuum like that necessary for the Geissler tubes; the air-bulb, as before mentioned, open to the air.

By means of adjustable resistances and batteries, the three lamps were brought to the same degree of red heat, as nearly as could be judged. The potential at the filament terminals and the volume of current flowing were measured in each case, with the result that the air-bulb required, to produce the red heat, 7·02 watts; the 1-10th inch vacuum, 5·336 watts; and the highest possible, 0·646 watts only. With the same lamps in series the highest possible becomes white hot with a current which scarcely causes visible redness in the air-bulb filament, and only dull redness in the 1-10th inch vacuum. The relative conductibility of the three bulbs, as measured by radiation upon a sensitive thermoscope, was—

Air, 325°.
1-10th inch vacuum, 250°.
Highest possible, 35°.

When the same filaments were raised to incandescence, that in the air-bulb required 31·2 watts per candle; the 1-10th vacuum, 15·20 watts per candle; and the highest possible vacuum, 4 watts only per candle.

These results show that of two similar lamps, one, merely from imperfect vacuum, may require double the current that is necessary in the other to produce the same amount of light, and at the same time become dangerously hot. The two extremes of my scale show, for example, the absorption of nearly eight times the force in the case of the air-bulb that is necessary to produce the same effect in the most efficient lamp with a higher vacuum. It is possible that vacua produced by chemical absorption of carbonic gas may be more perfect even than this, and advantageous to use. There is always some air left in a vacuum produced by a pump; but it is possible to imagine that no gas will be left unabsorbed in the case of caustic potash and carbonic acid gas being employed. Lamps which differ much in the state of their surrounding medium differ also in their behaviour when current is applied. Those which have a very perfect vacuum attain incandescence slowly, and lose it in the same way; while those which are imperfect start suddenly into incandescence, and as suddenly lose it.

* Paper read before the Institution, April 10, 1890.

DISCUSSION (AUTHORISED ABSTRACT).

General WEBBER asked Mr. Higgins if he proposed any means of testing the degree of exhaustion without using the methods ordinarily employed by lamp makers.

Major CARDEW inquired whether he had repeated his experiments with lamps having carbon filaments.

Mr. G. S. RAMM asked if his apparatus would indicate the difference between a vacuum of $\frac{1}{5}$mm. and the most perfect obtainable. In his (Mr. Ramm's) opinion there was a great need of something to replace the ordinary coil test, which in the case of carbon lamps was unreliable.

Mr. GRANVILLE wished to know whether the thickness of the bulb made any difference in the efficiency, for he thought the heat-conducting power of the glass must affect the temperature of the filament. He also asked if it would not be advisable to use double bulbs, so as to have the benefit of the diathermancy of both.

The PRESIDENT said the well-known method of testing the state of the vacuum by feeling at the bulb whilst the lamp is alight was a fairly good guide. He thought the differences observed by the author were not due to diathermancy, but rather to connection and diffusion.

Mr. HIGGINS, replying to General Webber, said his apparatus had been used practically. In one case he received a lamp which was supposed to be exhausted to $\frac{1}{10}$in., but his thermoscope indicated a lower vacuum. On returning the lamp to the maker his prediction was verified. His apparatus was so sensitive that it gave a deflection of 600 divisions if touched with the finger. In answer to Major Cardew, he said he had found the radiation from filaments of different materials to be alike. Referring to Mr. Granville's question, he said he had not tried the effect of different thicknesses of glass, but he believed it better to use large bulbs rather than small ones. As to the cause of the phenomena observed, he once suspected that convection was operative, but after investigating the matter had concluded that it had no effect.

ON ELECTRIC MOTORS IN GENERAL RAILWAY WORK.*

BY DR. LOUIS BELL.

(Concluded from page 577.)

I have been considering up to the present the sort of railroad work most unfavourable to electricity—that is, general work over long distances. There are, however, certain cases in which, even now, electricity could be employed to great advantage. For example, take railway lines between neighbouring cities, where the passenger traffic is large and frequent trains are run. If there were two competing roads, one operated by electricity and the other by steam, I should expect at least 50 per cent. more travel on the electric road, by reason of its freedom from dirt and smoke and attendant inconveniences. The same, I think, would be true in the case of very many suburban roads, and in those cases where the distances are comparatively short, I should expect lessened running expenses by the use of electricity. More especially would this be true if electric braking should ever be put into successful use. Up to the present, however, it has been one of the things very beautiful in theory and attractive in experiment, but which no one has cared to attempt employing.

The case, however, where an electric system would work to the very best advantage is the elevated railroad. In such a case we have a compact system which could be supplied from a single power station in the most direct and economical way. The damage to neighbouring property would be enormously lessened, and the present objections to an elevated system would be in a great measure removed. Of the success and economy of an elevated electric system there can be no reasonable doubt, and I would go so far as to say that, in view of what can be accomplished by electricity, there is no reasonable excuse for permitting the use of ordinary locomotives on an elevated system. The question has never been properly agitated; but if it were, I can see but one possible result. The difficulties of running an elevated system by electricity are immensely less than those encountered in the opera-

* Read before the Chicago Electric Club, March 17, 1890.

Digitized by Google

tion of a great street-car system, like that in Boston. In particular, the bugaboo of electric-railroad men—repairs, would dwindle into insignificance; for lifted from the dirt and mud of the street, an electric motor can readily be given such care as would reduce the repairs to a comparatively small figure.

Let us look into the gain that could be made by using electricity on an elevated line. It is, I think, a peculiarly favourable case, and we, fortunately, have the facts and figures at hand to determine its probable advantages. I will put aside for the moment everything except considerations of economy and running expenses, and I will turn to the New York elevated system for our facts. The locomotives on the Manhattan railroad work under conditions anything but favourable to economy. They are on duty 20 hours per day, and of that time steam is admitted into the cylinder but six hours. The full horse-power of the engine is 185, the mean horse-power is said to be 70·3; as a natural result of this the coal consumption is high, being 6·2lbs. per horse-power hour. Now, let us count the cost of fuel for each engine, and we have an average consumption of 435lbs of coal per hour. What coal consumption will be required to furnish 70·3 mechanical horse-power on an electric system of distribution? In the first place, we shall have the advantage of being able to use triple-expansion condensing engines and the corresponding coal consumption is about two pounds per horse-power-hour. This would mean something like 15lb. of water, certainly a reasonable figure. I shall allow 125 indicated horse-power to furnish the 70·3 horse-power required. This certainly is a liberal estimate, meaning as it does an efficiency of only 56 per cent. from engine to car. This allows 90 per cent. efficiency for the dynamos, 90 per cent. efficiency for line, and a little less than 70 per cent. commercial efficiency for the motors. This estimate is surely within safe limits, for if 90 per cent. is high for the line, surely 70 per cent. is low for the large motors, for at least this figure can be secured with a good street-car motor. Against, then, 435lb. per hour of coal required for the locomotive, we have 250lb. of coal per hour required to furnish the same power to the train electrically; and besides, the coal required for the locomotive is of a higher grade than that which would be used with a stationary engine; for it has been found best on these small locomotives to use a rather high grade of coal, whereas I have estimated the coal consumption for the stationary engine on the basis of a cheap coal, having an evaporative power of 7 to 7·5lb. of water per lb. of coal, and costing less than $2 per ton in New York. Bearing in mind these figures, we see that the saving of fuel must be considerable. The coal for the New York elevated road costs over $700,000 per year. In view of the facts I have just set forth, I think, on a conservative estimate, there will be a saving of $400,000 per year by generating the power at the central station and distributing it electrically. This means lessening the operating expenses of the system by a very perceptible amount. Apart from the bare cost of fuel, the saving and handling of coal and ashes and furnishing water will be no small item. But even this great saving in operating expenses would not represent the saving which could be effected in operating a new elevated road by electricity. In the first place, the damage to adjoining property would be enormously lessened by avoiding the noise, smoke, and dirt of a locomotive. In fact, I believe that the saving in the cost of right of way would go far toward paying the expenses of equipping the road electrically. But this is not all. The use of locomotives makes necessary the use of larger train-units. Larger train-units mean, on the score of safety, running at rather less frequent intervals; and that in turn means giving up that as yet unrealised ideal of rapid transit, small trains running at such frequent intervals that it would never be worth while to run for one. With lighter trains, running at more frequent intervals, the strain on the supporting structure would be greatly lessened, and the load more uniformly distributed; consequently the whole structure would be made light in appearance and reality, costing considerably less and being far less unsightly than those now in use. Taking this into account, it seems very probable that an electric elevated railroad could be built and equipped at a less cost than if it were to be operated by steam. The great ease with which small train-units are handled on an electric system should of itself be the strongest possible recommendation.

The question naturally arises, how could we equip an electric elevated road to secure the best results? This opens a wide field for discussion, and I can only enter it to give you my own personal views on some points which might be of advantage. Personally, I do not believe in the single car as the unit of transportation: firstly, because it increases the cost of equipment enormously; and secondly, because in running at a high rate of speed it is inconvenient to run independent cars as close together as is necessary to secure proper accommodation. On the other hand, I do not believe in long and heavy trains. The necessary speed for the service being known, I think the best general result would be obtained by using as many small trains as could be conveniently operated at the required speed. By small trains I mean trains consisting of motor-car, and say, two or three light passenger coaches. I am a firm believer in a motor-car, rather than motors placed under each car, for the very practical reason that motor isolated and placed in a separate car can be given immensely better care than would ever be received by a motor hidden beneath an ordinary car. If we are to secure the minimum of repairs and the fewest possible number of break-downs, I think it must be done by giving the motors steady and careful attention; and I believe this end can best be reached by a separate motor-car, so constructed that the motors and all the running gear can be under constant inspection. I see no objection to a composite motor-car containing compartments for passengers, provided the above condition is fulfilled. As to electrical equipment, I think the problem is not particularly difficult. The size of the motor to be used must be regulated by the train-unit proposed. Perhaps, for the unit suggested, two 30 horse-power motors would answer as well as anything. It should be remembered that, isolated as the elevated track would be, it would be practicable and safe to use higher potentials than is customary in ordinary street-railroad practice.

The distributing conductors on an elevated system could be arranged in whatever way would prove most convenient, quite irrespective of the present limitations. Neither would the amount of copper required be at all prohibitory. For example, take ten miles of double track, with the power station somewhere near the middle point, the wiring would of course correspond with the number of trains to be run; but, working on a three-wire system, with track as balance circuit, the equivalent of two copper rods one inch in diameter would serve to handle a very large equipment, and still give a high efficiency for the line. The weight of this conductor would be about 16 tons per mile of double track, certainly not a prohibitory amount. By using two power stations, this amount of copper could be reduced to one-fourth. If the amount should still seem too large another interesting possibility appears. Would it not be possible to operate an automatic block system of series distribution? By dividing the double track into sections, and supplying these from one or more power stations, it would be possible to avoid most of the difficulties of series distribution, without sacrificing much in the way of line efficiency. We must remember in this connection that the principle of electric braking is easier to apply on such a system than it is on a system of distribution at a constant potential, as ordinarily practised. Electrical braking has not been put into operation in a commercial way, but some competent authorities have estimated that the saving from its use might be as great as 40 per cent. in power required. Such saving would be well worth effecting, even if it were less than the above amount, unless there should be good mechanical reasons to the contrary; and inasmuch as working upon the block system would do away with many of the objections to series traction, I think, to say the least, this line of operation is well worth careful investigation.

In a great city like this, rapid transit is becoming more and more a necessity, and now, before great investments have been made, is the time of all others to try to forecast the future, and see to it that the rapid transit given the city is the very best that modern enterprise can secure. The reform cannot long be delayed; it is only a question of who will be the first to display the necessary enterprise and energy, and give this city a system of rapid transit suited to its needs, and to the age in which we live!

PARLIAMENTARY INTELLIGENCE.

HOUSE OF COMMONS.—TUESDAY, APRIL 15.

The Grievances of Telegraphists

Earl COMPTON moved: "That in the opinion of the House the present position of telegraphists in London and elsewhere is unsatisfactory, and their just grievances require redress." These grievances were of long standing, not only in the central office but in the provinces, and they extended also to Scotland and Ireland. Both males and females complained bitterly of the conditions under which they performed their work. That work had increased enormously since the introduction of the Fawcett scheme in 1881, and as the work had increased the grievances had increased also. Those grievances might be summarised under four heads—(1) the hours of duty; (2) the question of pay and salaries; (3) the question of classification and promotion; (4) the very burning question of meal-times. There was a complicated system of regular and irregular work and of overtime; and the principle upon which this was carried out seemed to be that of extracting the largest possible amount of work out of each individual at the least possible cost to the country. In the Fawcett scheme of 1881 it was laid down that as a rule there should be 16 hours' work for two days' work, and that was to be divided so as not to give more than 11 hours on any particular day. He contended that that scheme had not been adhered to. There had been weeks, particularly in the central office, when the hours of work had been 10 daily. That meant 20 hours in two days instead of 16 hours under the Fawcett scheme. It was said that this had been compensated in the succeeding week, when there were only 36 hours of work, or six hours a day. He maintained however, tha

Digitized by Google

was no compensation. This irregularity of hours was a great hardship to those who were working in the telegraph office. As regards overtime, he found that during the summer of 1889 for certainly a fortnight the telegraphists were worked something like 196 hours. That made 98 hours during a working week, including regular hours and overtime. He contended that those hours were too long for any public servant (hear, hear). He was unable to admit that the overtime work was completely voluntary. A man might volunteer for two or three hours' work, which, perhaps, might be extended to even 14 hours out of the 24. The men were called upon for overtime at a moment's notice, and one clerk was suspended for refusing to do overtime, though he pleaded ill-health as an excuse. As to annual leave, the telegraphists were asking for one calendar month's leave for those who had served 10 years, and three weeks' leave for those who had served less than 10 years. This demand was in accordance with what Mr. Fawcett had intended. The telegraphists had no Bank holidays, and worked on Sunday; and these facts ought to be taken into account. For his own part he wished that there were no Sunday labour; but, admitting that it was necessary for a certain number of telegrams to be sent on Sunday, Sunday labour should be limited as far as possible, and should be paid as full overtime. As to pay, the highest officials were, of course, well paid, and deserved to be. Since 1880 the pay of superintendents had risen from £300 to £400, while the pay of the assistant-superintendents had risen from £210 to £300. Before 1881 the maximum pay of the senior clerks was £160 a-year; now it was only £190, a rise quite disproportionate to that of the assistant-superintendents, who were next above the senior clerks. Moreover, senior clerks were in many cases doing the work of assistant-superintendents. The different classes of clerks had not increased in the same ratio, and they ought to be enlarged to permit of speedier promotion to the *maximum* of £190 a year. As it was, some clerks might secure their promotion in seven or eight years, while others might have to wait for 18 years, though all had equal qualifications and length of service. He hoped that something would be promised in connection with this matter of classification. Then there was the question of meal-times. There was at present no cessation of work for meals during the turns between 2 p.m. and 10 p.m., 3 p.m. and 11 p.m., 5 p.m. and 2 a.m., and 8 p.m. and 4 a.m. Sometimes, of course, the clerks might have spare moments, but very often their work was continuous. It would not be a satisfactory answer now to say that grievances were still under consideration; and he inferred from an answer given by the Postmaster-General last year that difficulties had not arisen from the interposition of the Treasury on financial grounds. He should like the House to be told whether there was any increase in the cost of the service through the passing of the Fawcett scheme, and whether the improvements promised under it had been carried out. If there were any deficit in the revenue from the telegraphs it was the fault of those who paid too high a price for them, and the telegraph clerks ought not to be made to suffer for that fault. The Treasury objected to the voting power of an organised agitation being brought to bear on the House of Commons, and threatened the suspension of promotion in any branch the members of which were henceforth known to adopt methods of extra-official agitation. He called it a monstrous doctrine that men were to be punished by taking from them the benefit of a scheme because they adopted what was called extra-official agitation (hear, hear). The action of the Postmaster-General in the Cardiff case proved that the right hon. gentleman concurred in the paragraph of the Treasury letter, and that made it necessary for the House to show that it did not object to men combining in a legal way, whether they were Civil servants or not. He asked that a speedy and reasonable remedy might be offered for these grievances. The duties of the operators were of a harassing character. Fifty per cent. of the telegraphists retired the victims of mental and nervous affections, brought on by bodily and mental fatigue. Juniors were expected to make progress in the knowledge of science and of delicate machinery, and seniors were expected to be scientists, linguists, and geographers. Cipher and code telegrams were enormously on the increase, and an error in a figure or word might be followed by the most serious consequences. The accuracy with which commercial and press telegrams were transmitted was well known to the public, who regarded telegraphists as a deserving body of public servants, to whom they would desire that justice should be done; and he had, therefore, pleasure and confidence in moving the resolution (cheers).

The motion was seconded by Baron F. J. de ROTHSCHILD.

Mr. RAIKES said that the noble lord had brought forward this subject at a time when the Government had not had an opportunity of arriving at any conclusion with regard to the proposal it embodied, while he had raised a number of small points of detail which were at the present moment occupying the attention of the Department. The noble lord had ranged the grievances of the telegraph clerks under four heads—namely, those which related to the hours of duty, to the rates of pay and allowances, to classification and promotion, and to the amount of leave. He complained that no official communication had been made to him with regard to the grievances of the London telegraph clerks before this motion was brought forward in that House, a course which he thought was altogether unprecedented (hear, hear). He could scarcely understand how the noble lord opposite, who had evidently taken up this subject most conscientiously, could have reconciled it with his duty to have brought forward this motion without having previously given the Department an opportunity of investigating the grievances which he alleged existed.

Earl COMPTON said that he certainly understood that a petition had been presented from the London telegraph clerks to the Postmaster-General on the subject. The petition, however, did not appear to bear a date.

Mr. RAIKES said that the only communication that he had received from the London Central Telegraph Office was a request made to him three days ago, some time after the noble lord gave notice of this motion, that he would receive a deputation which would present a memorial to him; in answer to which request he had directed a reply to be sent, appointing a day in the course of next week, when he hoped to receive that deputation, and to hear what those who composed it had to say (hear, hear). He was, of course, aware that there had been a petition flying about the country for some months past, which he had seen unofficially in the newspapers; but he might remark that the last persons to whom the grievances referred to in that petition were made known were the official superiors of the Department. The first petition on the subject that he had seen from the provincial offices had been one from Newcastle, which had been presented on February 28th in this year, and this had been followed by a great number of other petitions in identical terms from other offices. It was on March 4th, four days after that petition reached him, that he came to the conclusion that whilst it was not in his power to entertain or to recommend to the consideration of the Treasury several of the points that were raised by that document, yet that with regard to the other points he would take steps to secure their consideration by the immediate appointment of the best departmental committee he could select, upon which he would invite the Treasury to be represented, with the view of seeing how far the grievances complained of could be met (hear, hear) The Committee had only been sitting for a little more than a fortnight, and of course they had not yet been able to frame any report. He could assure the House that he had lost no time before endeavouring to probe to the bottom this question of alleged grievances. In the petition from Newcastle and in other provincial petitions which had reached him nine points were raised. With regard to four of these he should not be acting fairly by the men if he were to hold out any hope that their demands would be considered. In the first place, he could not encourage them to hope that the demand for the abolition of classification would be granted. Why should a cardinal principle of the Civil Service be modified in favour of one particular branch of the postal service? The abolition of classification in the telegraph service would entail an addition to expenditure in the service generally of £990,000 a year, for Mr. Fawcett having placed the telegraph service and the postal service on exactly the same footing, it would be impossible to improve the position of one branch and not to improve in a similar way the position of the other. The second demand which could not be entertained was the demand concerning the annual increment of the pay of junior officers. At present the increment was 1s. 6d. in the weekly wages, and the petitioners were anxious that it should be raised to 2s. Those who supported this demand needed to be reminded that these clerks had entered the service of the State on well-understood and recognised conditions (hear, hear). In their petitions they gravely stated that they were prevented from performing what they called "the duties of manhood" because their pay was so poor (laughter). What they meant was that they were not able to enter the state of matrimony eight or nine years before an ordinary member of the middle class would think of undertaking the burden of a family. Of course he should be very glad if all these deserving men, excellent servants of the State, were receiving much larger incomes. But the Government must consider what were the terms on which these telegraphists had entered the service of the State, and it was a little hard that they should be told that those terms, after they had been freely accepted, were inadequate and insufficient—nay, almost savage and barbarous in their results. They did not include the burning "dinner" question, which arose in London only; but he should be glad to consider whether he could include in the purview of the departmental committee any fresh point of that kind raised by the London memorialists as soon as he should have seen their petition. He would now tell the House what were the five points which he had referred to the departmental committee. The first was as to the sufficiency of present wages; the second was the request of the petitioners that all overtime should be paid for at the rate of one and a quarter; the third was the demand that all Sunday work should be paid for as overtime; the fourth was the demand that sorting clerks and telegraphists of ten years' or less service should receive three weeks' annual leave, and that those of more than ten years' service should have one month; and the fifth was the request that full pay should be allowed during absence from duty through sickness. He thought it extremely desirable, if possible, that he should be fortified with a unanimous report of the Committee before requesting the Treasury to take any action. He had decided, before these questions were raised in the agitated form in which they had recently been presented to the public, that there were three principal branches of the service which required special consideration. The most important were the superior officers of the Telegraph Department. The noble lord had referred to what he had heard from Liverpool that morning. Only a fortnight ago he obtained the sanction of the Treasury to a considerable improvement in the position of these officers at Liverpool. The consequence was that about 40 promotions had been made on the telegraph staff. Liverpool was the largest and most important centre; but it was intended to take Manchester, Birmingham, and other large towns in order. Although he had not been able to give any countenance to the proposal for the abolition of classification, which would in effect be the abolition of promotion by merit, it would be seen that he had not been slack in giving effect to the real requirements of the service, and that in advance of the demands made upon him. He sympathised with the case brought forward by the noble lord with regard to the hours of duty. But he was obliged, as the head of any department would be, to consider first the exigencies of the service. Reasonable care would, of course, be taken to prevent cases of hardship. It would be a scandal if the servants of the State were exposed to hardships which might easily be prevented. But, as everybody knew, the telegraph service was necessarily exposed to great fluctuations, in which occasional cases of hardship were inevitable. And he was sure that it would not be believed that the Department was indifferent to the hardships inflicted upon individuals (hear, hear). He could assure the noble lord that everything should be done which he could do to diminish any undue pressure (hear, hear). He had regarded the passage quoted from Mr. Fawcett's scheme as the recognised principle of the Department, that two days' work

Digitized by Google

should not exceed sixteen hours, and that no day should exceed eleven hours. The Secretary to the Treasury could bear witness to the importunity with which he had urged additions to the staff. But these questions were complicated by the considerations to which the noble lord had very fairly referred, viz., that the men who were complaining of overwork were not extremely in favour of additions to the force, because it diminished their opportunities of adding to their salaries by overtime. The noble lord would be surprised if he knew how great was the increase of the staff during the last few years. As regarded the dinner-hour in London, he did not see any great hardship if men whose hours were from two to ten were requested to dine before they came on duty. They were allowed time for refreshment between five and six, and it was enough if these men, who could hardly expect a life of luxury, were enabled to enjoy reasonable comfort. He admitted the exceptional character of the Submarine clerks, who had special claims on the consideration of the Department. They were handed over to the Government, which had but an imperfect knowledge of their position in their former employment. He had had the pleasure of meeting a deputation of these clerks, and had told them that though he could not promise the large gratuities to their widows which the companies had granted, yet he hoped to improve their position. The only other matter he could refer to was the circular issued from the Treasury under the Government of the right hon. member for Mid-Lothian. The responsibility for that circular rested with right hon. gentlemen opposite, and the quotation which had been made from it to-night was the first word he had ever heard of it. Whilst he thought that the language used in that minute was of rather too uncompromising and peremptory a character, he could not but think that it would be a bad thing for the Civil Service if its members were constantly to be bringing their grievances before Parliament. He hoped that, after the statement which he had been able to make that evening, the House would recognise the claim of every Government that the House would not interfere with matters of departmental administration except where they thought fit to censure the Minister in charge. So long as a Minister occupied his position at the head of a department, he ought to be allowed to conduct it in his own way. He ventured to hope that the House would leave questions of this sort in the hands of those who were directly and primarily responsible for them, in the belief that the grievances of the servants of any department were not likely to lack careful consideration, and, he believed, just and fair treatment. (Hear, hear.)

After some discussion, the House divided, when there voted—

For the motion	103
Against	142
Majority against	—39

The motion was therefore lost.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *April* 3, 1890.

An Electrical Trust.—A rumour which is floating about at the present time, and finds expression in an indefinite way in the newspapers, is much talked of in electrical circles. It is to the effect that the equivalent of an Electrical Trust is about to be formed. The parties to the Trust are variously stated as the Edison and Thomson-Houston Companies, and the Edison, Westinghouse, and Thomson-Houston Companies. It is hard to tell whether the rumour has any real foundation, though the name of Henry Villard, of railroad fame, is prominently connected with the supposed enterprise, as he is known to be much interested in electrical affairs. The latest report is that the combination will include at present only the Thomson-Houston and Edison Companies, and that the Thomson-Houston stock will be watered before the combination. All this, of course, is entirely unofficial, as those prominently interested in the case in question refuse at present to say anything about it. In the case of such a combination it is said that the motor business would be turned over to the Thomson-Houston Company, while the Edison Company would retain the lighting business. It is suggested that the Westinghouse Company, if not included at first, may enter the trust later. Of course, all this is mere conjecture, and whether anything will come of it time only can tell. The three companies in question have control, directly or indirectly, of an enormous proportion of the electrical business of the United States, so that a direct combination, or a mutual understanding even, would practically mean an electrical trust to control prices and distribute the electrical business of the country among the principals of the trust. The thing which seems to cast the most doubt on the report is the fact that there have been no preliminary overtures between the companies, and up to the present time they have been on terms anything but friendly, while the competition between them has been of the sharpest character, so that anything like an amicable agreement would be like a thunderbolt out of a clear sky. However, a few days, or possibly weeks, will prove or disprove the truth of the rumour.

Electrical Execution.—Public attention to electrical execution seems to be just now undergoing a revival. For the past few months the agitation has been fortunately subsiding, and in electrical circles it was thought that the obnoxious execution law would be repealed, and that the whole matter would become ancient history. A decision, however, of the Court of Appeals in the case of the condemned murderer Kemmler was decisive as to the constitutionality of the law; consequently, there are now half-a-dozen murderers under sentence to die by electricity, and unless there should be a pressure brought upon the Governor to pardon one or all of them, there will be at least one electrical execution within the present month; consequently public interest is again aroused, and the daily press indulge in ghoulish reflections over the possibilities of this method of taking a man's life. The whole affair has been unfortunate from the beginning in its effect on electrical interests, and meanwhile the Courts have been made the arena for a vicious combat between various electrical interests. Possibly, after one or two condemned men have been executed according to the provision of the law, public interest will die out, but at present the agitation which has been stirred up is anything but agreeable to electricians.

Electric Traction.—Several new storage-battery cars are in process of construction, and it is interesting to note that there seems to be at present a reaction towards a single motor for a car, instead of two motors, independently geared to the two axles, according to the present practice. There is also marked interest in devices by which motors can be kept running at full speed irrespective of the rate or direction of motion of the car. Several clutches for effecting this result have been devised and are in various stages of progress, although none of them as yet have been given a trial on a practical scale.

Report of the State Senate Committee on Electric Lighting.—The Committee of the State Senate, which has been investigating electrical matters in this city, has at last succeeded in evolving a report which on the whole is very satisfactory to electricians; and, considering the vast amount and varied character of the evidence which was taken, so favourable a result is rather remarkable. The general decision is in the line of requiring underground construction in all cities having 125,000 inhabitants or more, but it is gratifying to note that the Committee declined to give a partisan report in the case of alternating versus direct currents. Strong pressure has been brought to bear in the way of evidence, and several desperate efforts have been made to secure the complete prohibition of high-tension alternating currents. The evidence on this subject, it is unnecessary to state, was partisan in the extreme, and it is gratifying to see that the Committee did not allow themselves to be hoodwinked, but took the very sensible ground that while high-tension currents of any kind were unquestionably dangerous, they can be made safe by proper and reasonable protection. These precautions they demand, but positively refuse to discriminate against alternating currents. The report, too, was quite definite in opposing anything like an attempt to limit voltages to be employed. The Committee virtually said to the electrical public, "Gentlemen, you are dealing with a form of energy which may be, and sometimes is, dangerous to human life. You must take care to employ it in such a way as to reduce this danger to a minimum. We do not propose to limit the voltage which you may employ; but, as you raise the voltage, you must take reasonable precautions to better the insulation." It is to be hoped that no State law covering the ground broadly will be passed, as the probable outcome will be local supervision of a kind which would protect the public without imperilling electrical interests.

The Short Series System at Rochester (N.Y.).—Electricians interested in the traction problem will watch very carefully for the outcome of a recent large contract for electric railway apparatus. This is for the City of Rochester, N.Y., and the remarkable feature of the installation is the use of the series system, which up to the present time has been very little known

Digitized by Google

in this country. Recently the Brush Company has been pushing the Short-series system, which is the only one at all well known here, and this system is very soon to be applied to the Rochester street-car lines. The plant is to be a large one, the dynamo capacity being 1,100 horse power, and 100 cars are to be fitted with motors. It seems probable from these figures that the new system will at least be given a careful and exhaustive trial on a large scale, and the result may be that it will take its place as one of the practical systems in the rapid development of electrical traction that is now going on.

The Subway Question in New York.—Electric light companies here in New York are just now making vigorous efforts to get better underground accommodation. Between the influence of the company which has a contract for subways, public dislike of having the streets torn up, and, finally, public distrust of some of the companies, electric lighting interests are having a hard time of it. Some of the figures they have recently brought to light show that a change will have to be made, and that very soon, if electric lighting is to be extended as it should be in this city. The rent which the companies are compelled to pay for the subways is unquestionably exorbitant, and the subways, even at the present high rates, are not being finished rapidly enough for the demand. But there is strong public sentiment against allowing the companies to make their own subways and tearing up the streets as often as the pavements are put down, so that the final outcome of the fight is a matter of great uncertainty.

CORRESPONDENCE.

ALTERNATE *v.* CONTINUOUS CURRENTS IN RELATION TO THE HUMAN BODY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Whilst some of those present at the reading of the Paper by Messrs. Harries and Lawrence pointed out some of the fallacies in their method of experiment, the great divergence between their results or inferences and actual practice does not seem to have been brought out. Comparing the resistance table (Table E) and the sensation table (Table F), we find that the average dry-hand resistance to the intermittent current used is 1,740 ohms, and the average current that produced muscular fixation is 3·6 milliamperes, whence the mean or effective E.M.F. required to produce muscular fixation is $1740 \times \cdot0036 = 6{\cdot}36$ volts. Ten times this ought to produce death surely. This result is, of course, simply absurd in the light of everyday experience. I have often taken shocks from Wheatstone transmitters, using 60 to 80 Daniells without inconvenience, hands dry of course. Above 100 Daniells the shock is too great; but I don't remember to have seen a case of muscular fixation with less than 80 bichromates, say 160 volts. The Wheatstone transmitter gives, of course, a truly alternating current, but with much more abrupt changes of direction than most alternating dynamos. The higher the speed of the instrument, the stronger used to be the sensation effect. Perhaps Mr. Preece could get a transmitter lent to Messrs. Harries and Lawrence for their next set of experiments.

The measurements of resistance seem open to objection—at least, the quantity measured is not a pure resistance; and probably the results given by measurements made with alternating current would be different. The human body seems to behave—as I think Dr. Stone expressed it—like a series of leaky condensers, and therefore shows a lower apparent resistance to more and more rapidly changing potential differences.

The remarks as to "make" and "break" shocks at the end of the Paper seem to indicate that the authors are really unacquainted with the alternating-current dynamos and transformers in commercial use, or are under some curious misconception as to their mode of action.

Interesting as the Paper may be to gentlemen of their own branch of the profession, it is entirely misleading as to its title and the conclusions suggested as to the dangers of commercial alternating-current plant; and it is to be regretted that it will afford a new and powerful weapon to those who are opposing electric lighting in general or certain extremely useful systems now in use.

It is difficult to understand why the Council of the Institute allowed it to pass for reading, without, at least, such an alteration of title, and such eliminations and alterations, as would have prevented its being used as a "proof" of the danger of alternating currents, and have confined it to its proper place as a contribution to medical electricity.—Yours, &c.,

Oporto, April 8, 1890. HENRY M. SAYERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the discussion now going on in your columns as to the effects of alternating and continuous currents on the human body, it seems to me not enough attention has been paid to the fact that the most deadly currents are not necessarily the most painful.

Let any one who has an induction coil where the primary is interrupted by an ordinary vibrator take from it as strong a current as he can stand without feeling real pain, the vibrations being, of course, quite rapid; let him afterwards take the current under the same conditions as to strength, but with the vibrator screwed down so as to make permanent contact, the primary current being interrupted about twice or three times a second by means of a switch worked by another person. I know a number of people who find these sudden and complete contractions of the muscles, followed by an involuntary and total relaxation, at once terminating in another dislocating contraction, more painful than the almost, if not quite, continuous contraction or tetanus produced by very rapidly alternating currents. Does this mean that these last are the least dangerous?

Death by electricity does not appear to result so much from unnatural muscular contractions as from nervous exhaustion or disorganisation of the intimate structure of the nervous substance—*not* a result of an excess of current supposed to "burn out" a nerve like an electric wire, but a result of the excessive and unnatural molecular activity of its substance (it being generally conceded that ordinary nervous activity is a molecular action). That something of this nature is what actually takes place seems to be indicated by experiments made on dissected muscles and nerves. A freshly-prepared muscle and nerve will lift a certain weight, and can be made to do a certain amount of work for a certain time, by exciting the nerve with successive electrical "shocks"; but if a very rapidly alternating current be applied, so that the muscle be permanently contracted, its lifting force soon diminishes, and if the experiment is continued *the nerve dies* at once, and no amount of repose will restore its excitability, *i.e.*, its vitality. I need hardly add that had the nerve not been subjected to the alternating current, it would have retained its vitality (if kept moist) for a considerable time, during which momentary contractions might have been repeatedly provoked.

In the above experiment we approach more nearly to the conditions of the case in question, for we have experimented on living tissues, and have been able to compare their vital resistance to various electrical conditions. It seems to me that the shortest way to settle the question would be to make a series of experiments like the above, with the object of determining the relative effects of continuous and alternating currents, and which might be extended with advantage to living animals. Until this is done, the discussion will ever tend to become like the legendary dispute of the Ancients as to whether a live fish weighed more than a dead one.—Yours, &c.,

April 16, 1890. W. O. BAILEY.

DYNAMO AND MOTOR DESIGN.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reply to the letter which you published in last week's issue from "The Writer of the Abstract," please allow me to take exception to the "few words of explanation" which he offers.

Digitized by Google

In the "authorised abstract" the sentence occurs (*The Electrician*, March 28th, p. 528), "Laminating the cores has the effect of decreasing the divergence." What I said in my remarks is given in my letter published in your issue of April 4th, so I need not repeat it; but the sentence above quoted inaccurately represents half a statement. I think this kind of incompleteness is inadmissible even in an abstract.

Again, if "The Writer of the Abstract" will compare the corrected transcript of the verbatim report which was sent to me with the re-written copy he will find that they are identical, and that the words of the verbatim report stand practically *en masse*. The statement, therefore, that I found it necessary to re-write my remarks is misleading in the sense in which it is used. I would suggest that if a proof of the abstracts of discussion was sent to each speaker, in addition to the verbatim report, all difficulties of this kind would be avoided. Nobody wants to know what any speaker was *understood* to say; what he meant to convey alone can be of any value.—Yours, &c.,

W. B. Sayers.

THE DEVELOPMENT OF ELECTRIC TRACTION.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I have read and re-read with intensified interest the leading article, "The Development of Electric Traction," in your last week's issue, which has incited me to make these few remarks, partly corroborating some of the statements to be found therein. As regards the application of electric motors to street-car work, it is a well-known and universal fact in the electric world that it has now passed from the elementary and experimental into the commercial and utilitarian stage. This has only been accomplished by overcoming pioneering difficulties. I do not see why the application of electric motors to railway work should not as well be brought from the elementary and experimental stage into the more advanced one of commercial utility. Giving a glance at the horse-power required for an individual street car, and likewise for an individual train, it will at once be noticed that there exists a very different ratio; and this, to a certain extent, accounts for the non-application of electric motors to railways, as motors of such magnitude have not yet been demanded. Again, taking another glance in the direction of electricity as applied to illumination in this country, as compared with its application to motor purposes, it will be remarked that the former has made greater and more rapid progress than the latter; this also partly accounts for the present state of motor development. As regards the application of the electric motor to railway work, I see no reason why, with our present knowledge and with the many skilled electrical engineers, we should not yet have our trains thus propelled. I have keenly watched the successful application of electric motors to street cars during the most inclement weather, and do not see why electric motors applied to railway work constructed on the following lines should not be as successful as those applied to street cars:—(1) The motor must be properly and strongly designed, and at the same time well adapted to its work; (2) It must be thoroughly weather-protected; (3) Its carriage and gearing must be strongly constructed; (4) An attendant left in charge must *thoroughly* understand the handling of such a motor; (5) The motor when fitted in position and put to its work must be severely tested with varying loads before it is finally accepted. I beg to emphasise the last condition. If purchasers of any kind of machinery would have it put to its work and thoroughly tested, instead of having it tested at the manufacturer's depôt, they would, I am sure, have greater satisfaction. In conclusion, I beg to state that I hope the present generation will live to see the general application of electricity to railway work. It will, perhaps, have been noticed that I have not touched on transmission of power as applied to motors for railway work; but as I have encroached to a large extent on your valuable space, I have only to say that, where water-power is available, electricity can be generated and transmitted with a high degree of commercial success.—Yours, &c.,

Gerald St. John Day.

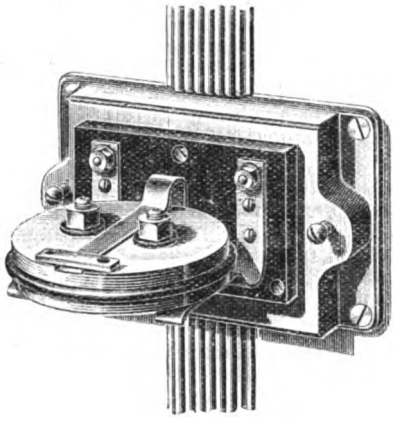
43, Polwarth-gardens, Edinburgh, April 13, 1890.

CARDEW EARTHING DEVICE.

Major Cardew's well-known automatic earthing device has been considerably modified by Messrs. Drake and Gorham. We give herewith an illustration of the latest pattern as finally adopted by the London Electric Supply Corporation after an exhaustive series of tests. The necessity for apparatus of this class was foreseen by Major Cardew some time back; and his patents, which are held by Messrs. Drake and Gorham, cover devices which depend for their action on static attraction. The static arrangement has been found to give good results, and has been adopted in the standard instrument as being less liable to derangement.

The action of the device, as is generally known, is to connect the secondary circuit to earth automatically whenever a dangerous difference of potential is established between the lamp circuit and earth. This result is obtained by interposing some medium which will be of infinite resistance until a high voltage exists, when a free passage for the current is provided.

The static device illustrated consists of two brass plates placed near, but insulated from each other. Between these lies a thin foil of aluminium, which is retained in position by ebonite pegs. One plate is connected to earth, and the other to the secondary circuit. A flat projection is formed on the upper plate, over one end of the foil, so that as soon as a difference of 400 volts is established, one end of the foil lifts by static attraction, and a metallic contact is made between the two plates. The main primary fuses are immediately severed by the increase of current, and the supply is cut off. The two plates are insulated by ebonite rings, and are securely bolted together, so that after being tested at the central station no skilled labour is required to fix them. It has been shown that the plates can be shaken or rolled about without affecting the voltage at which the foil will lift. The plates are carried by brass



Cardew Automatic Earthing Device. Front view, with cover removed

springs, to which the connections are permanently made at the back of a solid block of ebonite, so that the act of sliding in the plates makes the connections, and a slot on one side renders it impossible to put them in with the wrong side uppermost. The plates are all made interchangeable, so that when the foil has acted it is merely necessary to slide in some fresh plates.

This arrangement has a decided advantage over the method of earthing the secondary; for a strain is in this case permanently put on the insulation of the conductors, and a slight leak, which, with the automatic device, would remain harmless for years, is liable to be developed at any moment into a danger. This is specially the case in damp situations, where the size of the conductor may be reduced by corrosion.

It is evident that the apparatus can be modified to act as a relay, and cut off both poles of the circuit, or to ring a bell and drop a danger disc, as has been arranged for the Chelsea Electric Supply Company, where continuous currents are used.

In addition to the Deptford Company, the instruments have been supplied to the Newcastle Electric Supply Company; the Central Station at Lynmouth, Devon; the Shanghai Electric Company, &c.

Messrs. Baird, Thompson and Co.—This firm of ventilating, sanitary, heating, and consulting engineers, of Queen Victoria-street, London, E.C., and Bath-street, Glasgow, have purchased the patent rights and plant of the Æolus Waterspray General Ventilating and Electrical Engineering Company, and have also acquired the goodwill of the business that was carried on by this Company in Holborn, London.

Digitized by Google

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning.*]

TENDERS WANTED.—The Falcon Cliff Company, Douglas, Isle of Man, invite tenders for overhauling and putting in working order the electric lighting installation supplied two seasons ago. The tenders are to include working and maintaining the installation for the season, June to September, 1890. Particulars can be obtained from the Secretary.

APPOINTMENT VACANT.—The Fowler-Waring Cable Company, as will be seen by our advertising columns, require a General Manager, to undertake entire supervision, manufacture, and administrative duties. Application is to be made by letter, addressed to the Secretary, 85, Queen-street, Cheapside, E.C.

DISSOLUTION OF PARTNERSHIP.—It is announced that Messrs. Brittan and Foreman, telegraph engineers and contractors, of 21, Hermes-street, Pentonville-road, London, N., have dissolved partnership.

MESSRS. DRAKE AND GORHAM.—This firm have recently issued a well-got-up catalogue of electrical apparatus, giving illustrations, particulars, and prices of the horizontal pattern Cardew voltmeter, Messrs. Drake and Gorham's standard switch-boards, ring contact-switches, branch-way terminal-blocks and fuse-boards, excess indicators for dynamos or accumulators, battery-testers, including the Cardew cell-tester, and contact-rod for use with same. Amongst the principal users of these instruments may be mentioned—The Bank of England, the Royal Society, the Union Bank of London, the North British and Mercantile Insurance Company, the Woolwich Arsenal, the Aluminium Company (who have a standard switch-board for 4,000 amperes), the Leamington Central Electric Lighting Station, and a number of private mansions, ironclads, &c., &c. The catalogue is well illustrated.

Mr. ERNEST G. PINK.—Mr. Pink informs us that he has just completed an installation of the electric light at the new works of the Belvedere Company, Belvedere, Kent. The installation consists of two Crompton dynamos (arc and incandescent), nine Crompton arc lamps, and a large number of 16 candle-power incandescent lamps. Messrs. Crompton and Co. supplied the whole of the plant.

WOODHOUSE AND RAWSON (LIMITED).—Notice is given that the creditors of the original firm of Woodhouse and Rawson (Limited) are required, on or before the 12th prox., to send particulars of their debts or claims to the liquidators of the Company, 11, Queen Victoria-street, E.C. The solicitors to the liquidators are Messrs. Linklater, Hackwood, Addison, and Brown, 2, Bond-court, Walbrook, London, E.C.

AGRICULTURAL HALL.—During the current week a Sportsman's Exhibition and the annual show of the Kennel Club have been held at this Hall. A number of the exhibits at the recent Engineers' and Ironmongers' Exhibition were still on view, amongst them being Messrs. Paterson and Cooper's installation at the stand of Messrs. J. E. H. Andrew and Co., the Kent arc lamp installation, and the exhibits of Messrs. Crossley Bros. (Limited), the Campbell Gas Engine Company, and a few others.

COMPANIES' MEETINGS & REPORTS.

The Submarine Telegraph Company.

A meeting of the proprietors of the Submarine Telegraph Company between Great Britain and the Continent of Europe (Limited) (in liquidation) was held on Tuesday at the offices of the Company, 2, Throgmorton-avenue, London Wall, E.C., under the presidency of Sir Julian Goldsmid, Bart., M.P.

The following report of the liquidators was taken as read:—

The proprietors will recollect that they requested the liquidators to continue their negotiations with Her Majesty's Government, and endeavour to obtain a better offer for their cables. The liquidators immediately proceeded to further negotiations, but regret to have to report that they have been unable to obtain any increase in the offer for the Belgian cables, and an increase of only £3,000 for the French cables. The sum paid in respect of the Belgian cables was £9,998. 14s. 7d., and for this Company's French cables £14,999. 2s.

The sum paid for the steamer, leasehold properties, and furniture and fittings therein, was settled by valuation, and the valuation of the stores, batteries, instruments, &c., was made jointly by the officers of the Post Office and the Company.

The Belgian Government has paid the liquidators £127. 12s. 11d. for the testing huts on the Belgian coast; and the French Government has agreed to pay £1,000 for the Company's land lines in France.

The proprietors are, no doubt, aware that under the terms of the Company's French concessions, the salaries of the French clerks working the wires in the French cables had to be paid for by the companies; but, from some oversight on the part of the French Government, they omitted to send in to the companies at the time their account for the salaries of the clerks working the wires in the Havre cable from the year 1871 to 1883. The French Government discovered their omission in the course of last September. The claim was clearly one which could not be resisted by the companies, and the sum to be paid to the Government by the two companies was settled at the end of December last at £4,098, which sum, although not yet paid by the liquidators, has been charged in the accounts.

The profit realised on the sale of the securities forming the reserve fund amounted to £26,319. 5s. 9d.

With the sums paid by the Government and from the sale of the reserve fund securities, the liquidators have been able to return the capital to the proprietors in full. There now remains, as shown in the accounts, a balance of £26,840. 8s. 7d. to be yet disposed of, which will be further increased by the £2,000 caution money still in the hands of the French Government, when it is paid over to the liquidators.

A claim was made against the Company so far back as April, 1881, for alleged loss of light and air by a person occupying a house in London Wall, by the erection of the Company's premises in Throgmorton-avenue. The claim was brought before the Courts at the time, and the plaintiff was ordered to ascertain the value of the damage which he said he had sustained by the erection of the Company's premises. Instead of going on with the case, however, he let the matter drop until August last, when he resumed the action. What sum, if any, may be eventually awarded to him the liquidators are unable to say, but it should be an insignificant amount.

The liquidators now propose to make another distribution to the proprietors, to the extent of 7 per cent. of the capital, leaving in the hands of the liquidators £3,164 13s. 7d., which is subject, however, to the deduction of such sum as the proprietors may think proper to award to the liquidators for their services, and to the expenses that may be incurred until the close of the liquidation. The liquidators propose to distribute the balance remaining after these deductions, and the caution money, when they have settled accounts with the French Telegraph Administration, and with the person before referred to claiming compensation for alleged loss of light and air.

Mr. S. M. CLARE having read the notice calling the meeting,

The CHAIRMAN said that the Directors had had a hope last year that the liquidation would not take any considerable time. Hopes, however, were not always realised, and certainly they had not been in the case of the liquidation of this Company, which had taken a great deal of time, and had given much trouble. They would remember that the offer made to the Company by the French and English Governments was a very inadequate one. The consequence was that the number of interviews which he had had with Ministers and their subordinates on both sides of the Channel was very large, and the trouble the Board were put to in endeavouring to obtain a more suitable payment for the property they were handing over to the Governments was very considerable. They did get some increase on the offer originally made, but it was not so large as they would have desired. The French Government at one time was willing to extend the Company's concession, but that extension was prevented by the English Government. Then the two respective Governments changed *rôles*, the English being willing to treat them, on the whole, he would not say in a liberal, but in a reasonably fair manner; whereas the French were anxious to pay them as little as possible, irrespective of the merits of the case. Their position was this, that they were handing over a property which produced a very large and satisfactory income, and consequently they thought they ought to be paid something more than the amount at which the Governments chose to value the cables. However, they got all that they could get after a great amount of negotiations, and the result was, that, having realised the reserve fund, they were able to repay to all the shareholders the original amount of their investment in the Company. In the circumstances of the case he did not think that that was unsatisfactory. It was owing to the precaution of their having had a reserve fund that they were able to repay the whole of the capital. That fund was well invested by the Directors of the late Company, and had realised a profit of over £26,000. They proposed to distribute a further 7 per cent. of the total capital stock, which would make a return of 107 per cent. They were asked why it was that they did not wind up the Company at once. The reason was that, in the first place, the caution money, £2,000, which was deposited with the French Government years ago in order to prove that the Company were prepared to carry into effect the work which they undertook to perform had not been repaid; and in the second place they had to settle a great variety of accounts with the French Government, owing to the claims made on them by the French clerks—claims which they could not resist, and owing to the number of formalities to be gone through in connection with them, they had not been able yet to effect a settlement, although they hoped shortly to do so. The other reason was that a gentleman of the name of Bennet, who lived in a house next door to them, and who had complained that the light in his premises was so impaired by the construction of the offices where they were now assembled that he was unable to sell his pictures, had brought an action for damages for £400 against the Company, which had yet to be settled. The liquidators being of opinion that the claim was a preposterous one, thought that they would have hardly been consulting the interests of the proprietors if they did not defend the action. Having regard to the law's delay, he could not say exactly, therefore, when the accounts would be finally closed. The total amount outstanding, as they would see by the accounts, was the sum of £2,000 caution money already referred to and a balance of £3,164. 13s. 7d., which, added together, made a little over £5,000. Out of this they would have to pay the remaining expenses of the liquidation, whatever the cost of Mr. Bennet's action was, legally and otherwise, and the remuneration of the liquidators. Only one proprietor—and he was surprised that even one should have done it—suggested that two out of the three liquidators should not be paid, on the ground that they were well off. He could not entertain that opinion. They had done their duty, and he might say that he

Digitized by Google

had never taken more trouble in any business with which he had been connected than in endeavouring to get the best possible terms for the property of the Company. They were, therefore, entitled to some remuneration, the apportionment of which might be safely left in the hands of the liquidators, who could settle among themselves the proper amount due to each for the services rendered. The amount that would be given to the proprietors on the final liquidation would be 1 per cent.; that would leave roundly £1,800 for the payment of the expenses he had referred to, so that altogether in round figures they would get £108 for their £100 stock. They proposed to give 7 per cent. of that at once. He did not know that there was anything more for him to say, except that, under the circumstances, he thought the liquidation had turned out satisfactorily. They had not put the proprietors to much expense in carrying it out. He concluded by moving

"*That the report and accounts of the liquidators submitted to this meeting be approved and adopted, and that a further distribution at the rate of 7 per cent. of the capital of the Company be made to the proprietors on and after the 1st of May next.*"

The Hon. H. R. BRAND seconded the motion.

Mr. J. R. KING thought that, considering that two of the liquidators were Directors of the late Company, their services should be given gratuitously, more especially in view of the fact that there were ladies, and not a few, who had been most cruelly victimised by the winding up of the Company, which he characterised as most ungenerous treatment at the hands of the Government. Another reason why those gentlemen should not accept any remuneration was that upon a capital of £350,000 some four or five Directors had been receiving annually £2,000. Of course, he wished Mr. Clare's claim to be fairly considered, in consideration of the amount of work that that gentleman had had to perform. He was grievously disappointed at the winding up of the Company. As to the £4,000 claimed for French clerks' wages, the Directors must have been aware that the amount was due years ago, and ought not to have been charged against the Company now when it was being wound up. He wished to know also how many insulators there were in the Déolin cable, and what was the length of it.

Mr. CLARE: About 150 miles.

Mr. KING wished to know what had been received from that cable.

Mr. CLARE: We have received £12,281 for that cable, for which we had not to pay a shilling.

The CHAIRMAN explained that an agreement was made with the Paris and New York Company years ago by which that company paid for the cable. As to the item of the French clerks' salaries, owing to the fact that a new Minister was being placed in office every other nine months, the claim now made upon the Company had been omitted to be paid, although he did not know that it was the duty of the Directors to point out to the French Government that the money ought to have been paid. All he could say was that if the money had been paid before this time the Company would not have been enjoying the interest on it these nineteen years.

Mr. SIMPSON ROSTRON, while giving every credit to their late Chairman, as one of the liquidators, for what he had done for the shareholders, wished to point out that when Sir Julian Goldsmid took credit for returning the whole of their capital, he forgot to mention what chance the persons who bought, say at 220, had of getting back their money. Credit was taken for returning 107 per cent., whereas 5 or 6 per cent. of that was derived from working the concern for three months extra. He complained also of the secrecy of the negotiations between the Board and the Governments, and said that the moment the Directors saw that they were forced into a corner they ought to have thrown secrecy to the winds, and taken the shareholders into their confidence, with the view of resisting the exactions of the Government. One of their original mistakes was undoubtedly to lower their tariff at the instance of the Postmaster-General to a point below what they were entitled to charge, without making a distinct bargain as to getting their concession renewed at the end of its term.

Mr. BRAND, in reply, said that the Directors had been placed in a very disagreeable position. He had given as much as £265 for every £100 of stock which he held in the Company. At the same time he saw perfectly clearly, as every reasonable man must see, that the circumstances in which they were placed were such that neither the shareholders generally nor the Board of Directors could have avoided the disaster—if they liked to call it so—which had overtaken them. Up to within six days of the time when the English Government interposed, the Board of Directors had carried on negotiations to this point: that the French Minister had the pen in his hand to sign a renewal of the concession to the Company, and the Directors deliberately kept things secret in the belief that they were bound to succeed in their object. There had been no secrecy in the matter, and they had told the shareholders what had occurred within a week of the refusal to grant the renewal of the concession. The two last speakers complained of the action of the Government. So did he. They complained of the liquidation. So did he. But he wished to point out that the shareholders and the Directors were in a helpless position. The liquidation had been forced upon them by the Governments of France and of England. As to the remuneration of the liquidators, what the shareholders had to determine was the amount to be given, leaving to the liquidators themselves the question of its due distribution.

The CHAIRMAN said that he had gone to Paris over and over again to endeavour to get a renewal of the concession. Sir James Carmichael did the same thing, as did Sir Arthur Otway, with the result that they practically got from the French Government a promise that it would be renewed. He was unsuccessful, however, at the final moment because the English Government stepped in and prevented the signing of the contract, giving effect to the principle laid down by Mr. Fawcett when he was Postmaster-General that all the telegraphs should be in the hands of the State. Even so long ago as when Mr. Childers was Chancellor of the Exchequer he (the speaker) had endeavoured to arrange matters with the English Government, but without success.

The resolution was then put to the meeting and carried unanimously.

On the motion of Mr. THOMAS HIGHT, seconded by Mr. SIMPSON ROSTRON, it was unanimously agreed that a sum of £1,000 should be given to the liquidators for their services in the liquidation.

The CHAIRMAN next proposed:

"*That the balance in the hands of the liquidators, after the payment of all expenses, be distributed amongst the proprietors as soon as the liquidators have finally settled with the French Telegraph Administration and with the person referred to in the report claiming compensation for alleged loss of light and air.*"

Mr. ROSTRON having seconded the motion, it was agreed to *nem. con.*

The CHAIRMAN moved, and Mr. ROSTRON seconded:

"*That the books and papers of the Company—other than the account-books—as well as the books of the liquidators, be destroyed at the discretion of the liquidators after the expiration of twelve months from this date.*"

The resolution having been carried, a vote of thanks to the Chairman terminated the proceedings.

Montevidean and Brazilian Telegraph Company.

Dr. Charles Cameron, M.P., presided yesterday, at the offices, Token-house-buildings, E.C., over the ordinary general meeting of the shareholders in this Company.

The report of the Directors for the year ended December 31st last stated that the percentage of gross revenue receivable from the Western and Brazilian Company showed a slight increase, being £3,783, as compared with £3,604 in 1888. As the expenses for the year had been materially reduced, mainly because of the substitution of debentures bearing interest at the rate of 6½ per cent. per annum for the former 8 per cent. debentures, the balance to the credit of the revenue account was larger than that for any year since 1877—when the balance amounted to £2,344, as compared with £1,958 for 1889. But in 1877 only £500 was applied in redemption of debentures (instead of as now £1,000) and the large balance of £1,515 was brought forward from 1876. The percentage of earnings for 1877 amounted to £3,272, as compared with £3,783 for 1889. The Directors recommended the payment of a dividend at the rate of 4s. 6d. per share on the Preference shares, leaving a balance of £88 to be carried forward.

On the motion of the CHAIRMAN, seconded by Lieutenant Colonel G. W. MACAULEY, the report was adopted.

Bedford Electric Lighting Company (Limited).

The first annual general meeting of this Company was recently held at Bedford; Sir Henry Mance presided.

The CHAIRMAN said that the Company was formed in August, 1888, and this was practically the statutory meeting. They proposed to start in a small way, increasing it afterwards if they found it necessary, and they approached the Corporation with the object of obtaining permission, because they felt it would be useless to start a Company if the Corporation was in any way hostile to the movement. The Company offered very liberal terms, viz., that the Corporation might have the option of purchasing at cost price, or a little over, every five years, and he did not know that any more liberal terms had been offered to any Corporation by any Company in England. The Corporation could not make up their minds to give the permission, and commenced a series of investigations with the object of determining whether they could not do the work themselves. They had necessarily to wait another year, as the time had passed then for giving notice of their intention to apply for a Provisional Order; but when the time came round last year they gave notice of their intention to apply. With regard to the opposing Company in the field—the House-to-House Company—he had looked up the records at Somerset House, but found nothing to lead him to suppose that any serious opposition would be offered in that quarter. Knowing, however, that there was the possibility of other companies coming forward, they thought it best to put themselves in evidence, and they therefore issued a prospectus to assure the Corporation they were really in earnest. All they could do now was to await events. Meanwhile, they were not spending any money, and they would take care not to spend any until they were sure they could do it with advantage to the shareholders. If the Corporation made up their minds to do the work themselves, their occupation, so far as Bedford was concerned, would be gone. But his personal opinion was, that the Corporation would act very wisely if they gave it to a company, and if they did so he submitted that the local company had a greater claim to have the concern than any outside company that had recently come into the field.

Mr. Alderman Haynes, the retiring Director in rotation, was re-elected; and the meeting closed with a vote of thanks to the Chairman.

The Continental Metropolitan Tramways Company (Limited).

The third ordinary general meeting of the shareholders of this Company was held at Winchester House, Old Broad-street, E.C., on Monday, April 14th. Mr. B. H. Van Tromp presided.

The CHAIRMAN, in the course of his remarks, said that with the new concessions which the Company now possessed they had one especially favourable feature, for, amongst other things, they gave them the power to make use of electrical traction. He believed that there

Digitized by Google

was a very great future before electricity as a motive power; it was so clean and noiseless, there was no smoke, and it was so under the control of a simple-minded conductor, who could regulate the machine as easily as a child could turn a tap on or off, by simply touching a small valve. The growth of electric traction in America was so enormous that he contrasted with surprise the slow progress made in England in this direction. In the whole of England there were not 20 miles of tramway worked by electric traction. It was incomprehensible to him. In America there were no less than 1,500 miles of tramway worked by electricity, while in England we had not 20 miles. No less than 130 towns in America were served by electric traction. He was confident that electricity was the motive power for tramways from every point of view, including the vitally important point of economical working. The North Metropolitan Tramways Company in London, the Chairman of which (Mr. George Richardson) occupied a seat upon that Board, were, he was glad to say, showing some little enterprise in the matter of electric traction, and were running, or were allowing some one else to run for them, at Canning Town, experimental cars, the motive power being obtained from accumulators concealed in the cars. He learnt that the result of the working was very satisfactory, and that it was decidedly more economical than by horses. The cost of working had, he believed, been reduced by a penny per mile, from 6d. to 5d. per mile,

Mr. RICHARDSON: From 5½d. to 4½d.

The CHAIRMAN, continuing, said that there was at any rate a very distinct saving. He was glad to be able to report that an offer had been made to this Company by the Lineff Company to work a portion of their lines in Paris as an experiment by electricity, and the matter was under consideration. Under all the circumstances, he felt that it was possible that before very long there would be a considerable development of electric locomotion in Paris.

Mr. POWELL congratulated the Chairman and Directors upon the report presented and the results achieved. He was specially gratified at their obtaining the concessions referred to in the report. He had listened with satisfaction to the remarks of the Chairman on the question of electricity, with which he coincided. He, too, was astonished at the small progress made in this country in regard to electric traction compared with what had been done in America. There was, he said, a very important article in *The Times* of that day upon the subject of the progress of electric traction. He believed that the power to use electricity would prove to be a very important factor in the success of that Company. He was sure that the Directors were entitled to an exceedingly hearty vote of thanks for all they had achieved in the interests of the shareholders of the Company.

Mr. E. H. BAYLEY concurred with the remarks of the other speakers, and felt great credit was due to the Board. He regretted that the English should be so far behind the Americans in taking advantage of the use of electricity, which he felt had a great future before it; but not only was the country to blame in requiring an endless amount of trouble to be gone to, and Acts of Parliament to be obtained, but the local authorities and vestries delighted in throwing impediments in the way of tramway companies, and were not incorruptible bodies. He believed that this Company would prove a very great success indeed, and that it had a most brilliant future before it.

Mr. DUNLOP was exceedingly delighted to see the action that that Company, as representing English capital and enterprise, and French capital and enterprise too, was taking in the matter of the development of electric traction for tramways. He looked forward with considerable confidence to the future of the Company, and sincerely trusted that they would achieve the full measure of success that they deserved (cheers).

A SHAREHOLDER, who stated that he was connected with the Lineff Company, to which the Chairman had referred, said he would like to be allowed to offer a few words on the matter. He wished first of all to deal with the different methods of supplying the electromotive power to the cars; and dealing first with the system of accumulators, he desired to remark that they had been in use in Brussels for four years, but the results had not proved satisfactory; it had been found that electric traction could not be worked remuneratively by this method, and they were to be definitely discarded on May 1st. There were three other methods to which he desired briefly to refer: there was the method of conveying a continuous current to the cars by means of an overhead wire; and again, the method by an underground rail; but both of these had a variety of objections, and he was glad to be able to announce that the Company with which he was connected had now completed and perfected a system which was really invented for the benefit of this Company, by which a continuous current could be given without breaking up the roadway at all. He should shortly have the honour of inviting the Chairman and Directors of that Company to take a ride upon a full-sized car in London propelled in this manner; he hoped, within the course of a week or two.

The CHAIRMAN, in reply to a cordial vote of thanks, said he should be pleased to avail himself of the invitation to take a ride on the electric car referred to, and looked forward with confidence to the success of the experiment.

The Eastern Extension, Australasia, and China Telegraph Company (Limited).

The following are the report and accounts of the Directors of this Company for the half-year ended December 31, 1889, to be submitted to the thirty-third ordinary general meeting, to be held at Winchester House, Old Broad-street, E.C., on Wednesday, the 23rd inst., at 2 o'clock:—

The gross receipts, including Government subsidies, have amounted during that period to £264,105. 12s. 11d., against £238,854. 14s. 4d. for the corresponding half-year of 1888.

The working and other expenses, including £24,620. 10s. 2d. for cost of repairs to cables and expenses of ships, absorb £73,493. 19s. 3d., against £71,519. 7s. 4d. for the corresponding period of 1888, leaving a balance of £190,604. 13s. 8d. From this is deducted £2,864. 15s. 11d. for income-tax, £41,595 for interest on debentures and contributions to sinking funds, and £1,386. 7s. 3d. for additions to staff quarters, leaving £144,758. 10s. 6d. as the net profit for the half-year, which, with £26,236 1s. 8d. brought forward, shows an available balance of £170,994. 12s. 2d.

One quarterly interim dividend of 1¼ per cent. has been paid for the half-year, and it is now proposed to distribute another of like amount, making, with the interim dividends paid for the first half-year, a total dividend of 5 per cent. It is also proposed to pay a bonus of 4s. per share, or 2 per cent., making a total distribution of 7 per cent. for the year 1889. The balance of £58,494. 12s. 2d. has been carried to the general reserve fund, which, after being credited with the interest on investments received during the half-year, and a surplus profit resulting from a careful re-valuation of the spare cable and stores in hand, and debited with £76,461. 10s. 11d. on account of the cost of the Western Australian Cable, and further partial renewals of the Hongkong-Saigon cable, now stands at £710,113. 15s. 10d.

In pursuance of the conditions upon which the issue was made, the balance of 125 of the Company's Five per Cent. Debentures (1880) was drawn by lot on the 10th ultimo for payment at par on the 1st May next. 305 of the Company's Five per Cent. Australian Government Subsidy Debentures were also drawn by lot on the 1st instant for payment at par on the 1st July next. The numbers of the drawn debentures are given on pages 12 and 13 of the report.

The subsidy agreement with the Government of the Straits Settlements in respect of the Malacca-Singapore-Penang cables expired in August last, and a fresh arrangement has been entered into for a reduced subsidy of £400 per annum payable for an additional five years.

Several cable interruptions occurred on the Company's system during the half-year under review; but as nearly all the cables are duplicated,

PATENT
SILICIUM BRONZE AND SILICIUM COPPER WIRE.
The best for overhead Telephone and Telegraph Lines,
AND ALL ELECTRICAL PURPOSES.
Hard Drawn High Conductivity Copper Wire.
ROLLED AND DRAWN
PHOSPHOR BRONZE.
PHOSPHOR BRONZE
PHOSPHOR BRONZE VULCAN PHOSPHOR DURO METAL
PHOSPHOR BRONZE
BEARINGS, BUSHES,
AND OTHER PARTS OF
ELECTRICAL MACHINERY.
SOLE PROPRIETORS of the British, Indian and Colonial Patents,
THE PHOSPHOR BRONZE COMPANY (Limited),
87, Sumner Street, Southwark, London, S.E.
WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

Digitized by Google

the traffic was not materially affected, except between Australia and New Zealand, where telegraphic communication was entirely suspended from the 7th to the 20th August. This caused some dissatisfaction in the Colonies; and, although a second cable is not required for the traffic, the existing line being more than equal to its transmission, your Directors at once decided, with the approval of the Governments of New Zealand and New South Wales, to duplicate the Sydney-Nelson cable, so as to prevent, as far as possible, any further inconvenience to the telegraphing public. A contract was accordingly entered into with the Telegraph Construction and Maintenance Company for carrying out the work, and the cable has been manufactured and shipped, and is expected to be laid by the end of the present month.

In consequence of the frequent interruption of the Madras-Penang section off Penang and in the neighbourhood of the Nicobar Islands, where the ground over which the line passes is very rocky and uneven, and to avert as far as possible the danger of total interruption of telegraphic communication with the Far East which would result from the failure of the Madras-Penang cable simultaneously with the Rangoon-Penang cable, your Directors have decided to renew a considerable portion of the Madras-Penang section, laying the new cable along a more favourable course to the south of the existing route. A contract has been made with the Telegraph Construction and Maintenance Company for the manufacture and laying of the necessary cable, 650 nautical miles in length, and it is hoped that the operation will be completed before the next south-west monsoon sets in. All the Company's cables are now in good working order.

In accordance with the Articles of Association, Charles William Earle, Esq., and Sir Thomas Fairbairn, Bart., retire by rotation, and, being eligible, offer themselves for re-election. The retiring Auditors, Mr. Henry Dever and Messrs. Welton, Jones and Co. also offer themselves for re-election.

The Indo-European Telegraph Company (Limited).

The following is the report of the Directors of this Company for the year 1889, to be presented to the twenty-third ordinary general meeting of the members, to be held at Winchester House, Old Broad-street, E.C., on Monday, the 28th instant, at one o'clock:—

The Company's revenue from all sources for 1889 amounted to £108,282. 15s. 5d., as compared with £110,327. 7s. 7d. for 1888, showing a decrease of £2,038. 12s. 2d.

The expenses were: on commercial and general account, £28,637. 9s. 3d.; on maintenance account, £30,602. 17s. 6d., including £733. 8s. 0d. paid to the Russian Government; total, £59,240. 6s. 9d., as against £52,393. 4s. 7d. for 1888, an increase of £6,847. 2s. 2d. Deducting the above expenses, taking credit for £6,783. 18s. 7d. brought over from 1888, and debiting income tax, there remains the sum of £54,535. 10s. 3d. From this ainount £10,000 has been placed to reserve, and that sum, together with £10,625, amount of interim dividend, has to be deducted, leaving a balance of £33.910. 10s. 3d.

The Directors now propose the declaration of a dividend, for the six months ending December 31st, of 17s. 6d. per share, making, with the interim dividend already paid, 6 per cent. for the year, and a bonus of 20s. per share, both free of Income Tax, making in all 10 per cent., carrying forward £2,035. 10s. 3d. to the credit of 1890. This dividend and bonus will be payable on and after May 1st next.

It will be remembered that the balance brought over from 1888 was larger than usual, because, as then stated, "Provision has to be made for extensive alterations and additions to the system which must be effected during the current year, and the recent interruption of both the Company's cables in the Straits of Kertch has also entailed exceptional outlay, so that the whole of the additional amount carried over will be absorbed." The amount carried over was £6,783. 18s. 7d., and the additional expenditure, as appears under "maintenance," £6,847. 2s. 2d.

The falling-off in the revenues derived from Indian messages upon the reduction of tariff, remarked upon in 1887 and 1888, continued during 1889, but fortunately has again for the most part been made up by other traffic.

The International Telegraph Conference will meet at Paris in May next. The Company will be represented as heretofore by the Managing Director.

The following Directors retire by rotation, and offer themselves for re-election:—C. Holland, Esq., and H. H. Meier, Esq.

The auditors, Messrs. C. F. Kemp, Ford, and Co., public accountants, retire, and offer themselves for re-election.

Reuter's Telegram Company (Limited).

The following is the report of the Directors of this Company, to be presented at the 26th ordinary general meeting of the shareholders, to be held at the Company's offices, 24, Old Jewry, London, E.C., on Wednesday, the 23rd inst., at 12 o'clock:—

The Directors report that the net profits for the year ended December 31st last, after payment of current expenses, and deducting rebate on unexpired subscriptions, amount to £6,703. 10s. 6d., including £446. 1s. 7d. brought forward from the last account.

An interim dividend of 4s. per share was paid in October last, and the Directors now declare a further dividend of 6s. per share, making a total distribution for the year of 6¼ per cent., free of income-tax. This will absorb £4,590. 6s., and after adding £2,000 to the reserve fund there will remain a balance of £113. 4s. 6d. to be carried forward. The dividend warrants will be payable on the 26th inst.

The important negotiations which were pending at the time of the last general meeting have been brought to a satisfactory conclusion, and the Directors have pleasure in announcing that the friendly arrangements between the Company and the leading Continental news agencies, which expired in February last, have been renewed for a prolonged period.

The Directors regret to have to announce that Mr. Frederick J. Griffiths, owing to ill-health and a heavy bereavement, has resigned the secretaryship of the Company. They have accepted his resignation with reluctance, in order to relieve him of the routine duties of the post, but they have arranged to retain him on the staff. Mr. Walter F. Bradshaw, the assistant secretary, has been appointed his successor.

In conformity with the Articles of Association, the Hon. Mark Napier retires from the direction, but offers himself for re-election. Messrs. Welton, Jones, and Co. offer themselves for re-election as auditors.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—Notice is given that the fourth drawing for payment of the Five per Cent. Debentures (1884 issue)—153 in number—will take place on Thursday, the 24th inst., at 12.30 p.m., at the offices of the Company, Winchester House, Old Broad-street, London, E.C. The receipts of this Company for the week ended April 11 amounted to £3,888.

CONTINENTAL INDIA-RUBBER GUTTA-PERCHA COMPANY.—This Company has just paid a dividend of 27 per cent. It is intended to start another factory in Austria.

EASTERN TELEGRAPH COMPANY (LIMITED).—This Company announce the payment by warrants, on 1st May next, of interest for the half-year ending April 30, 1890, on their Four per Cent. Mortgage Debenture Stock. The transfer books will be closed from the 28th April to 1st May, both days inclusive.

MONTE VIDEO TELEPHONE COMPANY.—The Directors of this Company have declared an interim dividend on the Preference shares at the rate of 6 per cent. per annum for the half-year ended January 31st.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—At a meeting of the Directors held on Tuesday last, it was decided to recommend to the shareholders at the approaching general meeting that, subject to final First Preference Shares, and 27s. 6d. per share on account of arrears on the audit, a payment of 6s. per share dividend to 31st December last on the Second Preference Shares, be declared, and carrying forward £516 19s. 8d.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The directors of this Company yesterday decided, after placing £7,500 to the renewal fund, and £5,600 to the debenture redemption fund, to recommend at the forthcoming meeting a dividend of 6s. per share, free of income-tax, making with the previous dividend a distribution of £4 per cent. for the year ended December 31st, 1889, carrying forward £3,751.—The traffic receipts of this Company for the week ended April 11th, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £2,964.

THE NON-CONDUCTOR OF ELECTRICITY.

WAREHOUSE.

VULCANISED FIBRE,

PATENTED.

This new material is supplied in two qualities, Flexible and Hard.

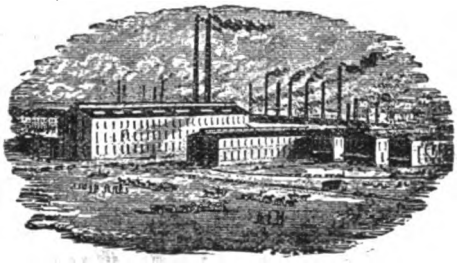
The FLEXIBLE is a substitute for Leather, Rubber, Gutta Percha, &c., and is extensively used by Brass Founders, Axle Makers, Hydraulic, Sanitary, and other Engineers, Pump Makers, Carriage Builders, &c.

It makes the best Hot and Cold Water Packings, and for Axle Washers of all kinds it is unequalled.

The HARD is a substitute for Metals, Hard Wood, Ivory, Vulcanite, Ebonite, &c., and is a good Insulator.

Sold in sheets, 5ft. 6in. by 3ft. 6in., varying in thickness from 1-50in. to 1in.

FLEXIBLE, 2/- per lb.; HARD, 2/3 per lb.


FACTORY.

MOSSES & MITCHELL, 70 Chiswell-st., London, E.C.

Digitized by Google

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Divi-dend.	Name.	Previous Week's Price, Wednesday, April 9.	Price Wednesday, April 16.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending April 16 1890. Highest	Lowest.
£			**TELEGRAPHS.**			£ s. d.			
1,770,360	Stock	15/0	Anglo-American	49 50	48½ 49½	5 11 1	Jan., Apr., July, Oct.	49½	49
2,614,520	Stock	30/0	Do. Preferred	83½ 84½	82½ 83½	6 11 9	" "	84¼	82½
2,614,520	Stock	...	Do. Deferred	14 14½	13½ 14¼	...	February	14½	12⅝
130,000	£10	3/0	Brazilian Submarine	12½ 12¾	12¼ 12⅝	5 17 8	Mar., June, Oct., Dec.	12⅝	12 5/16
112,900	£100	5%	Do. 5 per Cent. Bonds	100 102	100 102	4 18 0	January and July	100½	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	104 107	104 107	4 13 6	June and December.	...	...
16,000	10	9/0	Cuba Submarine	11 11½	11 11½	7 16 6	February and August	...	...
6,000	10	10%	Do. Preference 10%	17½ 18½	17½ 18½	5 8 1	" "	...	...
12,931	5	2/4½	Direct Spanish (£4 paid)	3⅝ 4¼	3⅝ 4¼	5 3 6	March & September	...	...
6,000	5	10%	Do. Preference 10%	9 10	9 10	5 0 0	April and October	...	...
60,710	20	3/8	Direct United States	10½ 10⅝	10 10½	6 16 7	Jan., Apr., July, Oct.	10 1/16	10 1/16
380,000	10	2/6	Eastern	14 14½	14 14½	4 11 3	" "	14 7/16	14 1/16
70,000	10	6%	Do. 6 per Cent. Preference	14¾ 15¼	14½ 15	4 0 0	" "	15⅛	14 15/16
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock	106 108	107 109	3 13 5	May and November.	108½	...
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	106 109	106 109	4 11 9	February & August	...	...
250,000	10	2/6	Eastern Extension	14⅛ 14⅜	14⅛ 14⅜	4 17 5	Jan., Apr., July, Oct.	14 3/16	14⅛
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	100 102	100 102	5 17 8	February & August	...	...
473,000	100	5%	Do. 5 per Ct. (Austln. Gov. Sub.) Debs. 1900	102 105	102 105	4 15 3	January and July	103	...
179,177	10	1/9	Globe Telegraph and Trust	8⅝ 8¾	8⅝ 8⅞	6 1 1	Jan., Apr., July, Oct.	8 1/16	8 1/16
178,992	10	6%	Do. 6 per Cent. Preference	14⅜ 14⅝	14⅜ 14⅝	4 0 8	" "	14⅞	14⅜
150,000	10	5/0	Great Northern	15½ 16	15½ 16	4 13 6	Jan., July, and April	16	...
17,000	25	12/6	Indo-European	41 43	41 43	5 16 3	April and October	42¾	...
9,000	8	4/0	Reuter's	7 7½	7¼ 7⅜	6 9 0	April and October	...	...
15,609	10	3/6	West African Telegraph	9½ 10½	9½ 10½	...	...	...	...
300,000	100	5%	Do. 5 per Cent. Debentures	98 101	98 101	4 19 0	March & September	101	100½
30,000	10	5/0	West Coast of America	9½ 10½	9½ 10½	4 15 3	January and July	10	...
150,000	100	8%	Do. Debentures 8%	121 126	121 126	6 7 0	June and December	...	...
88,321	10	nil.	West India and Panama	3⅛ 3⅜	2⅞ 3⅛	...	...	3¼	2¾
34,563	10	12/0	Do. 1st Preference 6%	11½ 12	11½ 12	...	April and October	12	11⅞
4,669	10	10/0	Do. 6 per Cent. 2nd Preference	14 15	14 15	...	...	...	...
45,181	15	6/0	Western Brazilian	10⅜ 11½	10½ 11	6 17 0	May & November	11⅛	10⅞
$1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	122 126	122 126	5 11 1	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	99 101	99 101	5 18 10	March & September	...	...
			TELEPHONES.						
224,850	14/0	5%	Consolidated Telephone and Maintenance	½ ⅝	½ ⅝	...	Yearly	...	...
220,000	£1	3%	Oriental (11s. paid)	¼ ⅜	¼ ⅜	4 8 3	...	...	...
80,000	5	3/0	National	5 5½	5⅛ 5⅜	...	June and December.	5 1/16	5
55,000	5	2/0	United River Plate	4½ 5	4½ 5	...	January and July	...	...
			ELECTRICITY SUPPLY COMPANIES.						
555,000	5	...	London Electric Supply	2⅝ 2⅞	2⅝ 2⅞	...	...	...	...
500,000	10	...	Metropolitan Electric Supply (£6 paid)	5½ 6	5½ 6	...	...	...	...
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
190,248	3	...	Brush Electrical Engineering	2¼ 2½	2¼ 2½	...	...	2½	...
353,478	5	7%	Edison and Swan United	...	...	...	...	...	...
409,000	10	...	Electric Construction	9⅞ 10¼	9⅞ 10¼	...	...	...	...
140,000	2	...	Elmore's Patent Copper Depositing	5⅝ 6½	5 5½	...	...	6½	5 1/16
41,600	10	10/0	India Rubber, Gutta Percha & T'l'graph Work	17½ 18½	18 19	5 5 3	February & August	18¼	17¼
78,949	5	6%	Swan United (£3. 10s. paid)	4½ 5	4½ 5	4 3 11	...	...	...
87,350	12	36/0	Telegraph Construction and Maintenance	43 45	44 46	5 3 11	March and July	45⅝	44

JABLOCHKOFF'S
DISTRIBUTION PATENT

(Being a Patent for "Producing and Dividing Electric Light," No. 1996 of 1877.)

THE
ELECTRICAL ENGINEERING CORPORATION, Ltd.

(STATTER'S) **Are Proprietors of the above Patent, and Warn the Public against Infringement.** (UNITED).

The following are Licensees:—

Brush Electrical Engineering Company, Limited.
Crompton & Co., Limited.
S. Z. de Ferranti.—London Electric Supply Corporation, Limited.
W. T. Goolden & Co.
Hammond & Co.
Wilson Hartnell.
Johnson & Phillips.
Laurence, Paris & Scott, Limited.
Nalder Brothers & Co.
Paterson & Cooper.
Ernest Scott & Co.
Siemens Brothers & Co., Limited.

3, Prince's Mansions, Victoria Street, Westminster. PERCY E. SCRUTTON, *Secretary.*

Digitized by Google

THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 623.—Vol. XXIV. FRIDAY, APRIL 25, 1890. Price Fourpence.

NOTES.

In reviewing on Monday last the work of the Electrical Trades Section during the past year, Mr. Crompton was decidedly apologetic. The bill of fare, to use the Chairman's expression, was indeed of a very modest character; but, after all, a newly-organised body, unless it be a London County Council, is perhaps best employed during the first year of its existence in perfecting its organisation and in ascertaining in what direction its energies may be turned with the greatest advantage. The Electrical Trades Section has, however, justified its existence by good work in connection with the establishment of the British Association screw-thread as a standard, the question of railway rates for electrical goods, the collection of electrical statistics, and the Edinburgh Exhibition; and now that there has been a large infusion of new blood on the Committee, and the ground has been in some measure cleared, we may anticipate that the Section will prove increasingly useful.

A Regretable feature of Monday's meeting was the exceedingly meagre attendance. A Section which numbers considerably over two hundred members might be expected on the occasion of its annual general meeting to muster in greater strength than eleven, or, if we include the Committee, eighteen. Unless support is given to the Section, the proposals and demands of its Committee cannot carry the weight that, in the interest of the whole electrical industry, it is most desirable they should. The marked success which has attended the efforts of the Association of Municipal Corporations in regard to municipal Provisional Orders is largely due to the fact that the Association was known to have the whole of the Local Authorities of the United Kingdom behind it; and the concessions which this body has obtained from the Board of Trade certainly do not tend to diminish the necessity for an equally powerful and representative organisation on the part of the electrical trades.

The examination of Sir Benjamin Baker yesterday afternoon in connection with the Central London Railway Bill, attracted a large number of persons to the room occupied by the Select Committee. The engineer of the Forth Bridge was throughout most emphatic in testifying to the advantages and possibilities of electric traction. What he had recently seen in the States had convinced him, he said, that the time was now ripe for the solution of the municipal rapid transit problem by means of electricity.

In our correspondence columns this week will be found a communication from Otto T. Bláthy, in which he shows how to obtain the exact value for the coefficient of self-induction of a circular loop of round wire. The result is of interest, as the expressions hitherto obtained only represent the result approximately. Maxwell has, indeed, worked out the case of a circular coil of wire of rectangular section, but the expression given consists of an infinite number of terms of great and increasing complexity. Mr. Bláthy has, in an ingenious manner, succeeded in expressing the solution in a complete and comparatively simple form.

The same correspondent, in offering some criticisms on the interesting paper of Dr. Harries and Mr. Newman Lawrence, alludes to several sources of complication, causing the results stated therein to be doubtful, and subject to debate. The matter is, however, even more complex than Mr. Bláthy indicates, for the electrostatic capacity of the human body is by no means inappreciable; and this, in conjunction with its high resistance, would produce a change in the apparent resistance of the body for rapidly varying currents. The method of resistance measurement suggested by means of a Cardew voltmeter and current-meter does not, therefore, seem very satisfactory. With the remarks on the effect of testing with various electric pressures we quite agree, more especially as the body may be regarded as a leaky condenser, and subject to all the vagaries well known to occur with them.

In our present issue will be found a brief account of the latest novelty in American electrical engineering, namely, the Westinghouse alternate-arc system. It will be noticed that it consists of a return to the original series system of transformer distribution under modernised and improved conditions. The details appear to have been carefully worked out, and several safety devices are described. In order to completely avoid the introduction of high potentials into houses, transformers converting in the ratio of 1·1 are used when the same current is required in the lamps as in the main circuit. The regulation of the dynamo for constant current is accomplished by means of the alteration in lag between E.M.F. and current due to varying the external resistance; and the way in which this effect is utilised for the purpose is exceedingly ingenious. A noteworthy point is that the frequency of the current alternations has been diminished from the very high value hitherto used by Westinghouse to one more approaching usual English practice. The system will be seen to have a high efficiency at

Digitized by Google

full load, and on the whole seems to be a promising solution of the arc-light problem.

It has often been stated in American publications that when current passes from the rails to the wheels of an electrically driven car, an increase in the resistance to skidding occurs. If the assertion were true, the fact would have important bearings; for not only would it be possible to make electric locomotives lighter than others, but, as the limit of speed is largely determined by the resistance to skidding and the impossibility of making engines heavy enough, applications to express work would probably be found.

Mr. Crosby has recently tested the matter by experimenting on a car weighing about 10,000lb., the currents being passed into the driving motors both directly and through the contact between the wheels and rails. The conclusion arrived at is that there is no appreciable difference in the adhesion in the two cases, although Mr. Crosby owns that his tests were too rough to decide whether any slight difference exists or not. It is unfortunate that he had not sufficient power at his disposal to drive the car, and that, consequently, he simply found the current required to make one pair of wheels skid when the carriage springs were relieved of part of their load by jacking up the car. It is, however, difficult to see how the mere motion of the car could make any difference. There are one or two points in the experiments requiring elucidation. Thus, it was found that, when the current jumped from 20 to 42 amperes, the wheels invariably skidded whether conducting the current or not; while, if the current were increased slowly, skidding did not take place till about 50 amperes. There, however, seems no doubt about the negative result obtained, especially as in the experience of the Sprague Company nothing has occurred to warrant any other conclusion.

The determination of the ratio of the electro-static and the electro-magnetic units of electricity, although nominally a comparative measurement only, presents, nevertheless, all the enormous difficulties of an absolute determination; and the values obtained by different experimenters have exhibited very large divergences from each other. As all electrical measurements made outside laboratories are in electro-magnetic units, the ratio in question may seem of little practical value, however immensely important from a theoretical point of view; but the extensive use of alternating currents will sometimes render it desirable to ascertain the capacity of leads and other condensers whose constants are easily obtained in electro-static measure, and in such cases a knowledge of the conversion ratio will be necessary.

Until recently the value of "v" was thought to be considerably under 300; but Sir William Thomson, in a lecture which was delivered before the Royal Institution, recalled attention to the subject, and described some experiments made in his laboratory, showing that the round number 300 represented the ratio very approximately indeed. We describe in another column the most recent determination of this quantity, made in the Cavendish Laboratory by Prof. J. J. Thomson and Mr. G. F. Searle. The experiments have been performed with the minute care and extreme accuracy which we now seem to expect from the school of Cambridge mathematical physicists; and the number obtained, 299·58, will at once take its place among the valuable series of reliable constants issued from the Cavendish Laboratory.

Mr. Shelford Bidwell's Paper at the Royal Society yesterday, "On the Effect of Tension upon Magnetic Changes of Length in Wires of Iron, Nickel, and Cobalt," was a very interesting addition to our knowledge of magnetic phenomena. Mr. Bidwell has discovered the existence of critical points due to tension in elongation of the above metals when in magnetic fields analogous to the well-known Villari critical point in their permeability curves. Prof. J. J. Thomson's prediction of the non-existence of a Villari point for nickel was recently contradicted by some experiments of Mr. Herbert Tomlinson, at least for permanent magnetism; and Mr. Bidwell's results lead him to conclude that the discrepancy is due to Prof. Thomson not having taken account of the effect of tension on magnetic elongations.

Our American correspondent reports that a recent telegraph tournament has resulted in the victory of a Morse operator, who signalled 260 words in five minutes—just 52 words a minute. What will our English telegraphists say to this? One of the conditions was that the sending should be "fairly readable"—a rather vague definition; but, even with this allowance, we should not have thought that anything like 50 words a minute was possible on an ordinary Morse key, for that is a speed which only the swiftest sender on a Bell instrument, where dots and dashes are of equal length, could achieve. If the words were of average length there must be something more in the American version of the Morse code than ever we have given it credit for. As a rule, the keying in this country is, we believe, faster than in America; and we wish some of our British operators could have competed on equal terms at that New York tournament.

The one thing satisfactory about the forthcoming execution by electricity in New York is that Mr. Harold P. Brown is to be the executioner. His performance with the lower animals proved that he had great aptitude for that kind of business; and nobody has a stronger personal interest than himself—except perhaps the victim—in making sure that the job is done smartly. A handsome gratuity will be due to Mr. Brown from those interested in low-tension systems, if he is successful.

Sir Frederick Bramwell is getting over his repugnance to decimal points and watts. Only two years ago he was saying that the only idea he could attach to a "watt" was that it was the $\frac{1}{746}$ part of 1 horse-power. Yet, at his discourse on Friday night last, at the Royal Institution, on the electric welding process of Elihu Thomson, he actually spoke about the watts of power supplied electrically, and used decimal points! There is now no doubt of the enormous power of the "new force."

Digitized by Google

THE series of articles by Mr. O. G. PRITCHARD on the manufacture of "Electric Arc-light Carbons," which concludes in this present issue, will shortly appear in pamphlet form. The reprint will contain additional practical information with regard to the building and organisation of an arc-light carbon factory, and will also deal with the financial side of the question.

Exeter.—The Exeter Electric Light Company has decided to apply for a Provisional Order, and to place its wires underground.

Konigsberg.—The town of Königsberg is about to raise the sum of 1,500,000 marks (£75,000) for the purpose of building a central station.

The Eastern Telegraph Company.—The Italian agency of this Company is removed from Otranto to 28, Via Venti Settembre, Rome.

Carlsbad.—A new central electric station is to be erected at Carlsbad by Ganz and Co., of Budapest. When completed, it will be the largest station in Austria-Hungary out of Vienna.

Schallenberger Meters.—The Westinghouse Electric Company have received an order from the Metropolitan Electric Supply Company for 750 Schallenberger meters of various sizes.

Submarine Cables Trust.—Notice is given that the ordinary annual meeting of this Trust will be held at Winchester House, 50, Old Broad-street, E.C., on Wednesday, May 7th, at one o'clock.

Vegesack.—The Allgemeine Elektricitäts Gesellschaft, of Berlin, intends to light Vegesack by electricity. Already 1,500 incandescents, 25 arcs, and 8 motors have been subscribed for.

Coatbridge.—At the last meeting of the Town Council it was resolved, by 9 to 5, to consent to the Scottish House-to-House Electricity Company getting a Provisional Order for the electric lighting of the burgh.

International Telegraph Conference.—The Government of Costa Rica will send a delegate to the forthcoming International Telegraph Conference.—Colonel Mallock, Director-General of Indian Telegraphs, will represent the Indian Government at the Conference.

Mexico.—The Compania del Gas of Mexico is erecting a central station in the Pasea de la Reforma. At present the building contains a 450 horse-power Fowler engine, with five Brush dynamos, running 400 arc lamps and 2,500 incandescents.

Church Lighting.—The electric light installation at the Chapel Royal, Savoy, has been completed by Messrs. B. Verity and Sons. The schools of the Savoy have also been similarly provided. The current is supplied by the Metropolitan Electric Supply Company.

The Telegraphs in Brazil.—A Reuter's telegram of April 19 states that a new department of Public Instruction and Posts and Telegraphs has been created by the Brazilian Government, of which Senhor Benjamin Constant, at present Minister of War, has been appointed Minister

The Late Prof. Joseph Henry.—There is a proposition before Congress to pay the two daughters of the late Prof. Joseph Henry, whose valuable work in the field of electromagnetism is so well known, $20,000 as part compensation for their father's 25 years' service as a member of the Lighthouse Board.

Deaths from Electric Currents.—In reply to a question by Mr. James, Sir M. Hicks-Beach stated in the House of Commons on Monday evening that the Board of Trade had received no official information as to the number of deaths from electric currents in the United States, but were endeavouring to obtain the information.

Junior Engineering Society.—The visit of this Society to the Deptford Central Station Works of the London Electric Supply Corporation will take place on Saturday afternoon, 26th inst. The party will travel to Deptford Station, South Eastern Railway, by train, leaving Charing Cross 3 p.m., Cannon Street 3.10, London Bridge, 3.14.

Extension of the Telephone System in the North.—The National Telephone Company have just completed their trunk lines from Inverness to Dingwall and Strathpeffer *viâ* Beauly, and have opened exchanges in Dingwall and Strathpeffer, which now become the most northern points touched by the Telephone Exchange system in Great Britain.

Royal Society.—The following Papers were down for reading at the Royal Society yesterday:—Mr. W. N. Shaw, "On a Pneumatic Analogue of the Wheatstone Bridge;" Mr. Shelford Bidwell, "On the Effect of Tension upon Magnetic Changes of Length in Wires of Iron, Nickel and Cobalt;" Dr. Hopkinson, "Magnetic Properties of Alloys of Nickel and Iron."

Moss Vale (New South Wales).—On March 1st the electric light was inaugurated at Moss Vale. The contract for lighting the streets was let to Messrs. Wood Brothers and Co., electrical engineers, of Petersham. The light was completely successful. The whole of the work has been under the supervision of Mr. E. Clarence Wood, B.Sc., M.E.E. The engine is by Messrs. Robey and Co., and the dynamos by Messrs. Mather and Platt.

Brussels.—The technical committee which has for some time past had the various schemes for the electric lighting of this city under consideration, has finally decided that none of them are acceptable from the financial point of view. It has, therefore, been decided to invite new proposals, and if these do not prove satisfactory, it is anticipated that the municipal authorities will exploit the electric light as well as gas.

The Archer Electrical Conduit.—The work of preparing for the electric lighting of the Chelsea Military Exhibition, which promises to be of some interest even to electricians, is proceeding apace. The whole of the underground cables are laid in the Archer electrical conduit, which consists of a special joint on a strong stoneware pipe. The joint is on the principle of a tongue and groove, and the liquid cement poured into the side of the groove grips the tongue on all sides, and forms a perfectly water-tight conduit.

Telegraphists' School of Science.—The thirteenth annual distribution of prizes and certificates in connection with this school was held on Wednesday last week. The Controller, Mr. H. C. Fischer, occupied the chair. Attention was especially drawn to the fact that the school had again secured the first honours prize in telegraphy in the United Kingdom, as well as the medal in the "Tools" examination under the City and Guilds of London Technical Institute. Altogether 88 certificates and 68 prizes had been awarded. The distribution was performed by Mr. J. C. Lamb, Secretary to the Telegraph Department. Mr. R. W. Johnston, Postmaster of Manchester, also addressed the meeting. The proceedings terminated with a vote of thanks to the Chairman.

Gelatinous Electrolyte for Accumulators. — From the *Elektrotechnische Zeitschrift* we hear that the Oerlikon Works have for some time been using accumulators having a gelatinous electrolyte formed by treating potassium or sodium silicates with sulphuric acid. The resistance of the cell is practically the same as that of the liquid ones, and the chemical reaction is the same in both. The treatment of the cells remains as before, except that they are charged at constant potential instead of constant current. The advantages of the new form are that no gas is evolved, short-circuiting through the dislodgement of the active mass cannot occur, and breakage of the glass does not immediately incapacitate the cell. The efficiency is stated to be from 80 to 95 per cent.

The Deterioration of Insulation.—We have received from Sir David Salomons a sample of insulated wire about 30 inches long, the insulated braiding of which is completely rotten and some 12 inches of which have flaked off. The sample in question forms part of a wire 30 yards long, all of which is, we are informed, in much the same condition. The wire was laid five years ago in pitched casing, running through a dry, well-drained tunnel. The portion of the wire in the house is quite good, but the insulation is very dry, and cracks on bending. The wire, which is about No. 16, B.W.G., has only carried ·025 amperes at a

Digitized by Google

pressure of 100 volts; and it would be interesting to hear whether the above has been the common experience with good insulated wire exposed to a by no means severe trial of its durability.

Marylebone Vestry.—At a meeting of this Vestry last week, a communication was received from the Metropolitan Electric Supply Company, in which the Company accepted the conditions imposed on them by the Vestry in relation to the laying of the Company's mains (*The Electrician*, April 11th, p. 566), and asking first that no further delay occur in the commencement of the work, and secondly asking for an extension of the time expressed in the agreement between the Vestry and the Company to 18 months. After some discussion a motion was put and carried to the effect "that the application of the Company for extra time be granted, subject to the term of the resolution passed at the previous sitting being endorsed upon the agreement and passed by the Works Committee of the Vestry."

Electrical Lectures.—The following is the syllabus of Prof. Ayrton's summer course of lectures, to be given on Mondays and Wednesdays, from 4 to 5 p.m. commencing April 30th, and which are open to persons who are not regular students of the Central Institution:—"The Laws of Self and Mutual Induction and their Application to Alternate-Current Circuits, and to Circuits with Fluctuating Currents;" "Practical Methods of Measuring Coefficients of Induction;" "Practical Use of Accumulators and Transformers, in Electric Distribution;" "Direct Current and Alternate Current Transformers;" "Testing;" "Power;" "Efficiency;" "The Absolute Systems of Electrical and Magnetic Units;" "The True and So-called Legal Practical Units;" "The Construction, Laying, and Testing of Submarine Cables;" "The Determination of the Position of Faults in Land Lines and Cables;" "Simplex, Duplex, Quadruplex, and Multiplex Signalling on Land Lines;" "Combined Telegraph and Telephone Systems;" "Simplex and Duplex Signalling through Cables."

Paddington Vestry.—A special meeting of this Vestry was held on Tuesday to consider the revised report of the Electric Lighting Committee. Colonel Barchard said the revised report of the Electric Lighting Committee differed but slightly from the original report. The committee was precluded by a previous resolution of the Vestry from again opening the question of the Vestry undertaking to supply the parish with the electric light. After considerable discussion, Colonel Barchard moved, "That the electric lighting in Paddington be carried out by a company or companies to be selected by the Vestry." The resolution, on a division, was carried by 18 to 13. After an attempt to adjourn the Vestry, Colonel Barchard moved a second resolution, setting forth that, as the Metropolitan Electric Supply Company (Limited) would deposit a sum of £20,000 under section 7 of the Model Order, also that the Company had agreed to all the alterations made by the Vestry in the Model Order, &c., the Vestry be recommended to withdraw its opposito this Company for a Provisional Order. Further discussion ensued, and amendment after amendment was fought over and defeated. At last the resolution was carried, on a division, by 14 to 10. Mr. Mark H. Judge then declared that the resolution was not carried by two-thirds of the members as it ought to have been, and it was not, therefore, legal. The Chairman, however, declared the resolution carried. Originally there were six applications before the Board of Trade; but when the final decision was made, all but three had been withdrawn, the competing companies being the House-to-House, the Kensington and Knightsbridge, and the Metropolitan. The Metropolitan have agreed to supply energy at 7½d. per unit, and meters up to 50-lamp for 10s. a year. There is also to be a small charge for transformers. The question of public lighting was not considered by the Vestry.

Brighton.—At the last meeting of the Town Council Councillor Ballard moved a resolution to the effect that the Town Clerk should be instructed to write to the Town Clerk of Bradford requesting information as to the number of lamps wired, whether 5d. per unit was capable of being sustained, and what was the total cost paid by the Bradford Corporation for the installation, asking at the same time for two diagrams showing the average and maximum output of the plant. He said it appeared to him to be a matter of absolute certainty that according to the electric lighting scheme passed by the Council, they must lose £1,500 or £2,000 per year. Councillor Blaker contended that the Committee had made a mistake. The building estimate was understood to be £3,000, whereas he knew, or believed, that the work was now estimated to cost £5,755. In this building estimate alone the work would cost nearly 100 per cent. more than the estimate. If every item increased in a corresponding degree, the expense they were running the town into would be enormous. He asked them to let the matter be held over for a time. He moved as an amendment that Councillor Ballard's second notice of motion be taken with the first. It was as follows:—"That no further proceedings be taken under the resolutions as to the Electric Lighting passed at the meeting of this Council held on March 3rd, 1890 (except such of them or so far as this Council may be legally bound), until the further resolution of this Council." Alderman Ewart said he felt justified in saying that in the aggregate the tenders would not exceed the estimate, £3,000. With regard to the getting of information from Bradford, the Committee had got all the information which the Bradford Corporation were now prepared to give. He might say that the Brighton charge of 6d. per unit was established after a profound analysis by Alderman Hallett. The Town Clerk said the Brighton Company had at present an application before the Board of Trade for a Provisional Order. Should the matter be deferred, according to the motion, the application would inevitably be granted. A division was then taken on the amendment, which was lost by 17 votes to 10. The original motion was also lost.

Electric Lighting in Massachusetts.—The following particulars from the fifth annual report of the Board of Gas and Electric Light Commissioners of Massachusetts may prove interesting:—In the State there are 75 gas companies, 26 of which have the right to supply both gas and electricity, and 100 electric light and power companies, many of them recently incorporated. Only about three-fourths of the electric light and power companies were actually engaged in business at the close of the year. While the consumption of gas for private lighting is constantly on the increase in the State, its use for street lighting is decreasing each year, electric light taking its place. The electric light plants owned by gas companies are valued at $724,527, as against $341,174 in 1888. These figures are for the year ending June 30th. The total capitalisation of 102 electric light companies doing business in the State is $4,837,085. The highest capitalisation is that of the Boston Electric Light Company at $1,000,000. During the year 15 companies paid dividends varying from 1 to 21 per cent., this last including an extra dividend of 15 per cent. The total amount of the dividends was $172,372.10, which, on the basis of the total capitalisation of 102 companies, is equal to about 3·56 per cent. The first electric light company incorporated in the State was the Lowell Company in 1881, that being the only company incorporated that year. In 1882 there were three companies incorporated; in 1883 there were four companies incorporated; in 1884, one company; in 1885, three; in 1886, 13; in 1887, 14; in 1888, 31; and in 1889, 54. On June 30, 1889, the central station engine-power was equal to nearly 19,000 horse-power. The total number of arc lamps in use was 5,463, and of double-carbon lamps, 3,375. Plain carbons were used to the number of 1,086,477, and copper-plated carbons to the number of 2,776,746. The largest consumer was the Boston Electric Light Company, which used a total of 1,445,087 carbons. The total horse-power of electric motors in use on June 30, 1889, was 1,442, furnished by 538 motors, of which 111 were on arc-light circuits, 379 on incandescent-light circuits, and 48 on power circuits. The station supplying the largest amount of power was the Edison station in Boston, supplying 233 motors aggregating 623 horse-power, all on incandescent circuits. There were 2,438 incandescent lights furnished for commercial purposes off arc-light circuits. From incandescent circuits there were furnished a total equivalent of 73,386 16 candle-power lamps. At the end of the year there were 7,494 public lamps, 3,053 incandescents, and 4,441 arcs. The largest public consumer is Boston, with 935 2,000 candle-power lamps.

Digitized by Google

MAGNETISM IN IRON AND OTHER METALS.*—XV.

BY PROF. J. A. EWING, F.R.S.

(*Continued from page 592.*)

§ 66. **Magnetisation of Mechanically Hardened Iron.**—In all the examples which have been given above the iron was annealed or softened by heating to redness. Iron which has been mechanically hardened—by hammering, rolling, wire-drawing, or straining in any way beyond the limit of elasticity—shows much less permeability and susceptibility, much less residual magnetism (when tested in the form of an endless specimen), and considerably more coercive force. Thus the retentiveness of hardened iron, when in the form of a very long rod or a ring, is less than that of soft iron; but a short rod holds more residual magnetism when hard than when soft, on account of its greater coercive force.

These differences combine to give the curves of magnetisation of hardened iron a roundness of outline by which they are readily distinguished from those of soft iron.

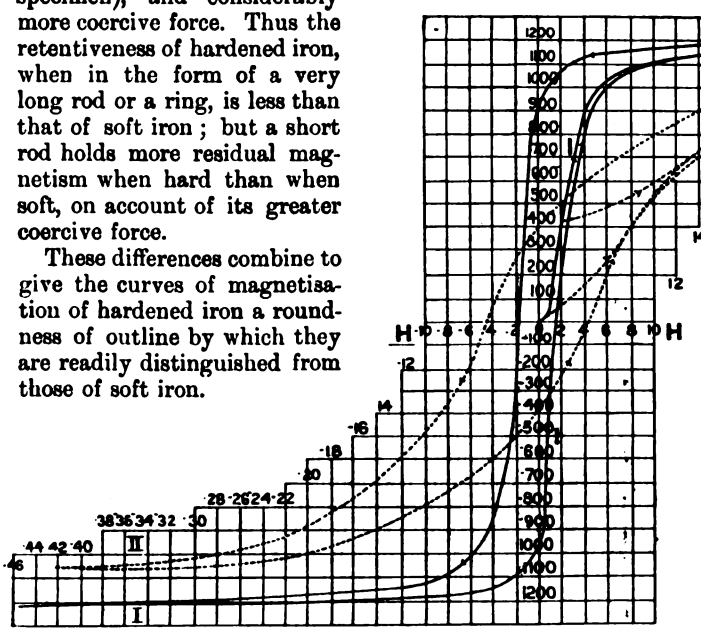


Fig. 34.—Cyclic magnetization of a soft iron wire.
(I.) After annealing. (II.) After being hardened by stretching.

The altered characteristics of the curves are well seen in Fig. 34, which shows the result of two experiments made (by the one-pole magnetometric method) on the same piece of iron wire†. In the first the wire (0·158 cms. in diameter and 60 cms. long) was annealed, and subjected to a cyclic magnetising process between the limits + 46 and − 46 of H. The results are shown by the full lines of the figure. The wire was then demagnetised by reversals, and hardened by stretching through about 10 per cent. of its original length. After the stretching weight had been removed, a cyclic process of magnetisation was gone through, the results of which are shown by the dotted lines. In this figure the ordinates are the intensity of magnetism I.

In the soft state, the maximum of susceptibility occurs early, at a force of 2·6, and its value (κ) is 245; the maximum permeability is 3,080. In the stretched state the maximum of susceptibility occurs much later, at a force of about 11, and its value is only 53: the maximum permeability is 670.

In the stretched state there is less than half as much residual magnetism as in its soft state. But stretching has increased the coercive force from 1·7 to 4·5.

§ 67. **Magnetic Qualities of Steel.**—Speaking generally, the curves of magnetisation for steel can be made to resemble closely those for iron by simply altering the scale of H. Under strong magnetic forces the region of saturation is reached in steel with much the same value of I or of B as in iron; but to reach it, or to remove it, requires the application of a stronger force. At every stage the susceptibility and permeability are less in steel, and the coercive force is correspondingly greater.

The name "steel" covers as large a variety of magnetic qualities as it does of mechanical. Beyond the differences which result from difference in chemical composition, the range is extended by the effects of mechanical treatment, and above all by the effects of annealing, hardening by quenching, and tempering. As a rule, steel which is mechanically soft or "mild" is magnetically soft, its permeability is comparatively high, and its coercive force is low; and steel which is mechanically hard is magnetically hard. Thus, if we compare samples differing in their percentage of carbon, we find, as a rule, corresponding differences of magnetic hardness; the harder samples—that is to say, those with more carbon—are less susceptible and have more coercive force. Again, as regards the effects of temper, specimens which have been hardened by quenching from a red heat are magnetically much harder than specimens of the same composition which have been annealed.

Other constituents than carbon affect the magnetic quality, often very greatly. Chromium and tungsten increase the coercive force immensely; and tungsten, in particular, is a usual constituent in magnet steel. In soft iron, as we have seen, the coercive force is about 2, or sometimes even less. In chrome steel, hardened by quenching in oil, it is 40, and in tungsten steel it may exceed 50.* These numbers are taken from a Paper by Hopkinson, which contains the most important

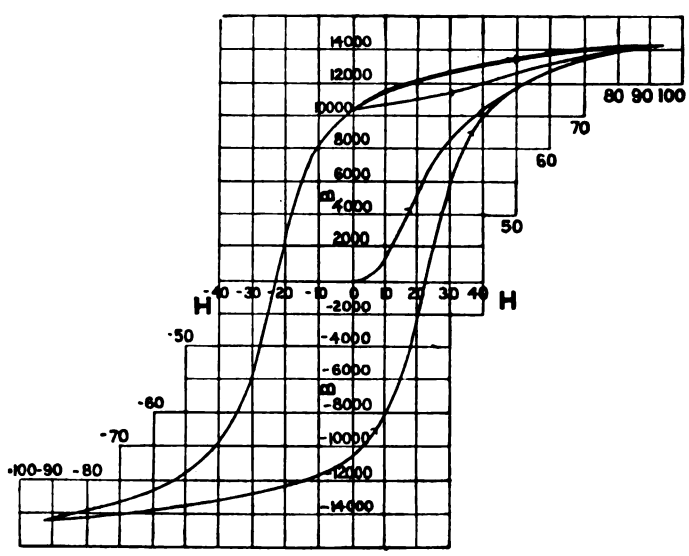


Fig. 35.—Pianoforte steel wire annealed.

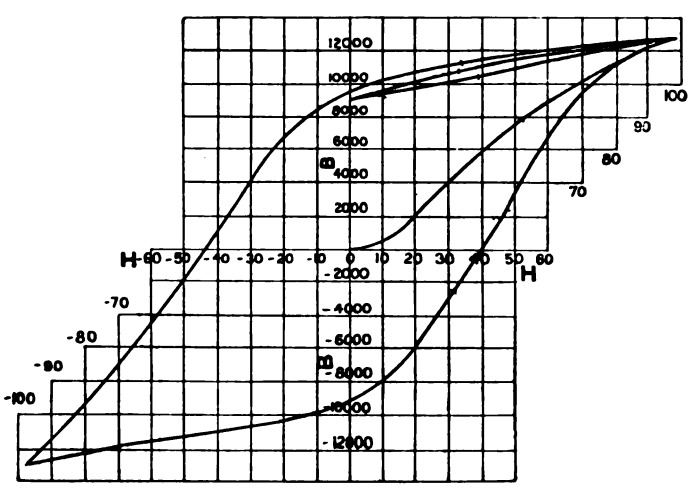


Fig. 36.—Pianoforte steel wire glass hard.

* All rights are reserved. † *Phil. Trans.*, 1885, p. 547.

* Hopkinson, *Phil. Trans.*, 1885, p. 463.

Digitized by Google

data at present available regarding the magnetic quality of steel. The value of his results is much enhanced by the fact that a chemical analysis of each sample is given. We shall have occasion to recur to them later, when giving collected numerical results. Meanwhile, it may suffice to illustrate the magnetisation of steel by a pair of examples taken from another source.

§ 68. **Magnetisation of Pianoforte Steel Wire.**—Figs. 35 and 36 show the results of cyclic processes of magnetisation (with positive and negative magnetic forces ranging up to nearly 100) applied to two pieces of the same pianoforte steel wire, one (Fig. 35) softened by annealing; the other (Fig. 36) glass-hardened by quenching in water from a red heat. The coercive force in the latter is scarcely inferior to that of tungsten steel. The maximum permeability is only 118; in Fig. 35 it is 295.

(To be continued.)

ELECTRIC ARC LIGHT CARBONS.

BY O. G. PRITCHARD.

(Concluded from page 570.)

Every manufacturer of carbons has, doubtless, a way of his own of coring carbons. I have experimented on three very different methods, and I now explain them. The most certain, the best, but I must also add, the slowest way, is as follows:—Take the finished carbon, and fit a small funnel, with a nozzle large enough to fit close exteriorly, partially filling the funnel with graphite powder, purified, and fired at a white heat in a graphite crucible, and then tamp the powder. With a little practice this is quickly done, but scarcely quick enough for

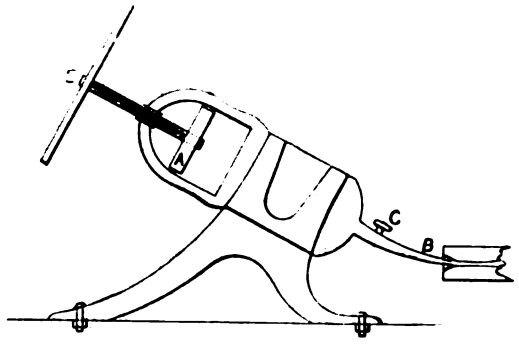


Fig. 12.—Coring Machine.

commercial purposes. The core, however, by this method can be made hard or soft, as desired. The second method is performed much more rapidly by using a specially-constructed coring machine. Before, however, describing it more particularly, I must mention certain difficulties. If the powdered graphite is mixed with water, on applying pressure with the screw the water separates, rising above the piston, whilst the powder hardens with the pressure and becomes like stone. Powdered graphite mixed with caramel fills the carbons easily, but after firing the carbon becomes harder than the ordinary lead pencil, and is spoilt. If oils are used, or liquid gums, the core is partially driven out in drying, the medium having a tendency to swell, so that the carbon is but partially filled, and the paste becomes attenuated and honeycombed when it should be close and solid, and the carbon may flicker. The only medium that answers, as far as my experience goes, is heavy mineral oil, with a specific gravity of 1·82. Mixed with this, I have not found the carbons swell nor get too hard when fired. The third and last method which I wish to mention is the gravitation method. A cask partially filled with the powder is placed under a tap of running water. This cask communicates with boxes packed with carbons by means of pipes, and as the cask runs over it fills the boxes, and the fine powder floating in the water gradually subsides, filling the core-holes. The cask requires stirring up occasionally. Where many thousands have to be cored this process will be employed, the system being automatic. The surface water should be decanted when the carbons are completely covered, and the boxes removed to the third drying-room, and left to dry, when the carbons may be withdrawn, wiped clean, and dried upon the shelves.

The coring machine (Fig. 12) explains itself. A is the piston actuated by a screw revolving upon the wheel E. C is a tap fixed to the nozzle B, which, tapering, enters the core-hole of the carbon. The finger is placed at the end of the carbon. Two or three turns of the screw will put sufficient pressure upon the material to fill several carbons, by simply turning the tap at C, which must be turned on and off as required. This method of coring must be adopted after the carbons are saturated and

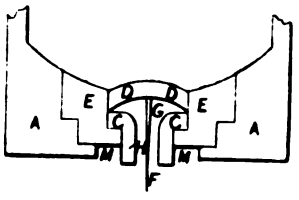


Fig. 13.—Die and Needle.

have been washed for the last time, the core hole being wet and allowing of the free passage of the paste. The pointing of the carbons is most easily effected on an emery wheel, revolving, as all emery wheels should to be of any use, at a high speed, 1,200 to 1,500 revolutions per minute.

I now come to an important matter, the construction and adjustment of the dies and coring needle. The pressure to which this needle is subjected when embedded in the pugged stuff is

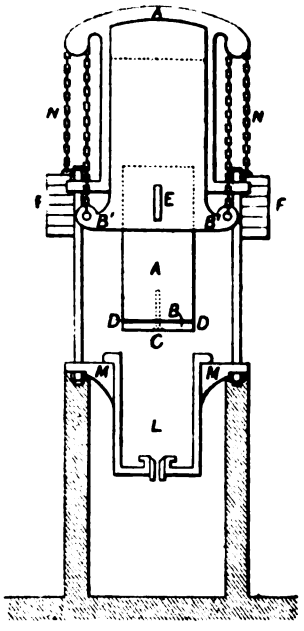


Fig. 14.—Hydraulic Press.

enormous; 120 atmospheres have to be resisted. On more than one occasion I have had the wings of my coring needle crumple up like paper; and to prevent this a proper form must be employed. A A (Fig. 13) represents the sides and base of the cylinder, E E a loosely-fitting die resting upon this base. C C is the die proper. The coring needle F must be screwed into the wings D D, which are four in number. The size of the core-hole will be determined by the size of the needle at H, no matter what the thickness of the shoulder. The die proper C C is sunk below the outer die E E, so as to allow the wings D D to find a bearing against the outer die E E. The wings are made sharp-edged above, gradually thickening to 4 mm. at the base.

Digitized by Google

The coring needle, when properly adjusted, will always be central, unless the wings get twisted by the pressure. The motive for making the die E E fit loosely is to facilitate the removal of the needle and the inner die. When necessary this is most effectually done by taking a copper tube, placing it at M M, and striking it with a heavy hammer; this will bring up the pugged stuff and the dies, instead of picking out the pugged stuff; the proper die will also be preserved from damage.

The hydraulic press (Fig. 14) which I had constructed was made of steel, but this is quite unnecessary, cast iron will do perfectly, since it will not be required to stand a greater pressure than 200 atmospheres; the ram should be 12in. diameter; and the plunger quite 8in. diameter if it is required to turn out 20,000 10mm. carbons per week. With a cylinder holding the pugged material 10in. deep, the plunger is keyed into the ram at E, so as to be removable, if necessary. The weights F F consist of iron slabs, 1cwt. each, suspended from the chains N N. Five slabs on either side are quite sufficient to raise the piston. The chains are fastened to the lugs B' B', which are part of the casting. The cylinder L with collar C drops into the framing M M, fitting tight, to prevent rocking. These parts must be made with greatest nicety. When the piston A has descended to its greatest depth it is sure to jam, unless the cylinder is strongly fixed. This may be done in many ways, and need not be explained, but must be attended to. I have employed a leverage of at least 50 tons to separate the piston from the cylinder. Not only must the cylinder be immovable, but the piston must be treated in the following manner. The piston must be lengthened, say 1¼in., by a piece screwed on to the piston end by the screw C, the head well let into a counter-sink. The addition must be a shade larger in diameter than the piston proper, with a small groove, D D, at junction. Before the piston enters the cylinder a little heavy lubricating mineral oil should be rubbed round the piston. After I had adopted this very simple plan the pugged stuff never clogged the piston higher than the groove D D, and the piston always rose unaided.

The manner of setting up the press needs no description; but being some five tons in weight, requires a good foundation. A word about the pumps. Sometimes the high-pressure pump gets out of order, a fact known by the arrested motion of the descending carbon-rod. Either the suction valve, or the cut-off valve, is out of order, or leaks. To dismount the pump is needless. Empty the tank, and wash it out with hot (not boiling) water. Throw washing soda, or soft soap, into the water, making it pass through the pump to cleanse the valves, which in time invariably become clogged with grease. The ram has constantly to be greased to keep the collar soft and pliable. Sometimes the piston of the pump requires repacking. Besides these annoyances—easily remedied—the pumps should work indefinitely.

Before I conclude I would like to mention (as it may not be thought sufficient to take the raw graphite ignorant of the amount of pure carbon it contains) a method of testing this raw material. This, indeed, should be done repeatedly, and samples kept, marked with the results of the analysis. By this means experience will be gained, and the look will almost be sufficient guide. Take and pulverise a small sample taken from the bulk, and dry it well at a temperature of 380° F., so as to make sure that all the moisture has been driven off. Take one gramme of this powder and 20 grammes of oxide of lead, also well dried; mix them thoroughly together and pour them into a hard glass test-tube, five or six inches long and half-an-inch diameter. Weigh the tube and its contents carefully, and submit the tube to a white heat under a Fletcher's blowpipe until all gases are driven off and the contents completely fused. Allow the tube to cool, and weigh the residue in the tube. The weight lost is carbonic acid, the oxygen of which has been taken from the lead oxide, while the carbon is all that there was in the graphite. For every 20 parts of loss there must have been 12 parts of carbon.

Some time ago, in hunting over patents at the Patent Office, I came across a patent (provisional) for saturating carbons. I have never tried it, but I give it here for what it is worth, and I hope not to the injury of the patentee. Steep the carbons in a dilute solution of calcic chloride, afterwards into a saturated concentrated bath of potassa chlorate (at a boiling temperature), dry afterwards by heat, and whilst hot steep in another bath of fused sodic nitrate, and wipe clean whilst hot. What effect this Turkish bath may have upon the carbons I am not prepared to say, but I think it might be worth a trial.

A NEW TESLA ALTERNATING MOTOR.

In its issue of April 9th the *Electrical Engineer* of New York describes the latest type of alternate-current motor devised by Mr. Nikola Tesla.

The motor (Figs. 1 and 2) has two laminated magnetic pole-pieces, C C', of soft iron or steel. The laminated disc-armature

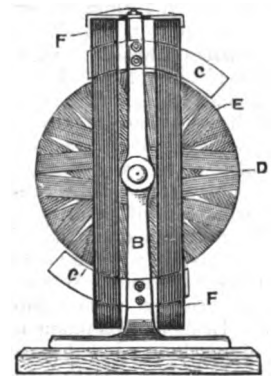


Fig. 1.—New Tesla Alternating Motor. Side view.

D is mounted between the pole-pieces C C', which are curved to conform to the circular shape of the armature. The latter is provided with a closed coil winding. The main energising coils F F are arranged so as to include within their magnetising influence both the pole-pieces C C' and the armature D, the pole-pieces C C' projecting out beyond the coils F F on opposite sides, as shown.

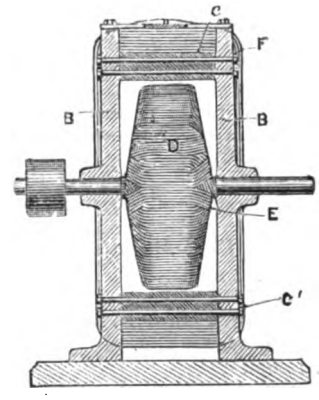


Fig. 2.—New Tesla Alternating Motor. Elevation.

If an alternating current be passed through the coils F F, rotation of the armature will be produced by the repellant force between the more closely approximating points of maximum magnetic effect. This effect is continued by the reversal of current, the polarities of field and armature being simply reversed.

One or both of the elements—the armature or field—may be wound with closed induced coils to intensify the effect. Although in the motor shown there is but one of the fields, each element of the motor really constitutes a field, wound with the closed coils, the currents being induced mainly in those convolutions or coils which are parallel to the coils F F.

Digitized by Google

RESEARCHES ON THE REVERSAL OF POLARITY OF SERIES DYNAMOS.*

BY M. A. WITZ.

Series dynamos are subject to sudden reversals of polarity, and I was led to the study of this phenomenon by coming across a machine of an extremely unstable character. I was engaged on some transmission of energy experiments, and employed for that purpose two small Edison machines, which only differed from each other in the method of exciting their fields. The generator was connected in series, while the receiver was separately excited. The machines having been started, the difference between the two E.M.F.'s remained constant so long as the opposing couple was the same. The slightest decrease, however, in the work to be done caused the receiver first to speed up, then suddenly to slow down, and finally to stop and reverse. A periodic reversal of motion then took place with surprising regularity, identically the same number of revolutions being made first to the right and then to the left. As the poles of the generator were reversed at the same time, we had the phenomenon of a periodic reversal of polarity in a series dynamo. This curious phenomenon, which I thought was unknown, had, so M. Hospitalier was good enough to point out to me, been previously observed by that distinguished physicist, M. Gerard Lescuyer, to whom in 1880 it was an inexplicable electro-dynamic paradox. To-day the phenomenon is, as I shall endeavour to show, less mysterious.

The experiment can be repeated in any laboratory with any series machine driving a magneto or a separately excited motor. If the receiver were also a series dynamo, we should have a demagnetisation of the generator, and a consequent stoppage of the receiver. The alternations of polarity and of rotation are easily produced when the magnets are of soft iron, and with some difficulty when they are of cast iron. The stronger the field of the receiver the more rapid the reversals. When the receiver is fitted with a fly-wheel the experiment is facilitated, especially if the receiver is running light. In short, this phenomenon is not peculiar to any particular type of machine; but it is easer to produce with some machines than others, and it was this consideration that induced me to carefully study the little machines which possessed such unusual sensibility.

The most singular characteristic of this periodically reversed rotation was the following. After having reversed the poles of the generator, the receiver first of all exhausted the energy stored up in its fly-wheel, and then revolved in the reverse direction until its velocity was sufficient to reproduce the phenomenon. Now, this velocity was relatively small; considerably less than that necessary to make the counter E.M.F. equal to that of the generator, as indeed the following figures will show. The generator making 1,781 revolutions, a Gramme laboratory machine attained a maximum speed of 252 revolutions; now the 252 revolutions of the receiver could only develop ·98 volt—that is to say, at the most, one-tenth of the E.M.F. of the generator. Another observation which I made is worth recording. An ammeter placed in the circuit showed that at the moment when the reversal was about to take place, the current slowly fell to zero, and then suddenly attained a value $-i$ equal to its permanent value. I would also remark that a variation in the resistance in no way contributed to the reversal of polarity.

In order to give an exact description of these various complicated phenomena, it is first of all necessary to set out the exact data of these machines.

Field Magnet.

Diameter of wire = 2·8 mm.
External diameter of the magnet = 110 mm.
Diameter of the soft iron core = 35 mm.
Height of the magnet = 234 mm.
Resistance = ·25 ohm.
Residual magnetism = 100 C.-G.-S. units.
Commencement of saturation = 12 amperes.
Strength of field at 12 amperes = 2081 C.-G.-S. units.
,, ,, ,, 14 ,, = 2124 ,, ,,
Coefficient of self-induction at ·3 amp.; $L = ·354 \times 10^9$ cm.

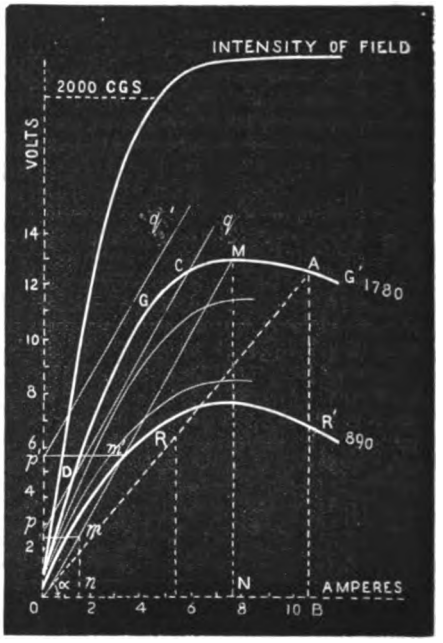
Armature.

Diameter of wire = 1 mm.
Diameter of ring = 72 mm.
Breadth of ring = 64 mm.
Resistance cold (static) = ·4 ohm.
Resistance hot (dynamic) = ·6 ohm.
Equivalent area = 72,000 sq.
Number of bars on commutator = 17.
Coefficient of self-induction for ·2 amps.; $L = ·476 \times 10^9$ cm.
Normal speed = 1780.
,, current = 7.
,, volts = 13 5.

* From *La Lumière Électrique.*

The accompanying figure shows the characteristic at 1,780 and 890 revolutions, and the curve of the strength of the magnetic field at the air-gap for various exciting currents. From the diagram it will be seen that these machines presented no anomalies; but I must call attention to their high self-induction, which explains the large difference between their static and dynamic resistance, and which, of course, is an unfavourable feature where transmission of energy is concerned, since the loss due to self-induction is equal to $N L \frac{I^2}{4}$. I will now endeavour to explain the phenomena observed.

Let us suppose that energy is being transmitted under the conditions of maximum output defined by Jacobi's law; the fields being equal, and the speed of the motor being half that of the generator, their respective curves will be R R' and G G'. The efficiency (P) of 50 per cent. will be realised if the total resistance R is equal to 1·19 ohm. In fact, if the line O M makes an angle A O B such that tan A O B = R, we can easily see that the counter E.M.F. e is half E; hence $\rho = \frac{1}{2}$. But as the resistance of the generator when at work is ·85 ohm, that of the motor ·6 ohm, and that of the leads ·25 ohm, R = 1·7 ohm and O M must be at an angle of 60 deg. Hence E = M N = 13·6 volts and $e = m n = 2·72$ volts; the efficiency being, therefore, only 20 per cent.—very bad conditions to work under, imposed by low E.M.F. of the current, and the relatively large resistance of the machines. Now draw $m p$ parallel to the axis of x, and $p q$ parallel to O M; $p q$ cuts the curve of the generator both at C and D, and the value of the current at C is its real value, which will remain constant so long as the speed of the machines does not vary. But diminish the resisting couple of the motor, and its speed will immediately increase and the ordinates of its characteristic will become higher.



The counter E.M.F. becoming greater, $p'q'$ replaces $p q$, for the two points C and D have become one; the secant has become a tangent, and there is no intersection except on the other branch of the curve; the current has also decreased to zero, and then increased negatively—the precise phenomenon observed. We can also see from the diagram that if the ordinates of the generator curve were lowered, the same result would ensue. The ordinates are lowered when the current decreases, since the strength of the field *ipso facto* diminishes. In short, this second effect is added to the first, and operates in the same direction. I observed above that the reversals were more rapid in proportion as the field of the motor was stronger. This should be so, so long as the characteristic curve of the motor rises in proportion to the increased strength of field. It can also be seen that an increase in the circuit resistance ought to have no effect, since the speed of the motor is diminished as well as that of the generator.

In short, these reversals of polarity are by the light of the diagram no longer a paradox, and we can understand how it is possible to reverse the poles of a generator by means of a motor of far lower E.M.F. than that of the generator. These considerations, however, while telling us how things happen, do not tell us why they happen. The phenomenon of the extreme instability of the magnetism of the field-magnets remains unexplained. A more stable field could no doubt be attained by employing more massive magnets and a stronger field, which would at the same time greatly increase the efficiency of the arrangement.

Digitized by Google

A DETERMINATION OF "v," THE RATIO OF THE ELECTRO-MAGNETIC UNIT OF ELECTRICITY, TO THE ELECTRO-STATIC UNIT.*

BY PROF. J. J. THOMSON, M.A., F.R.S., AND G. F. SEARLE, B.A.

The experiments made by Prof. Thompson in 1883 having given a value for "v" considerably smaller than the one found in several recent researches, it was thought desirable to repeat the experiments. The method then used was to find both the electro-static and the electro-magnetic measures of the capacity of a condenser, the electro-static measure being calculated from the dimensions of the condenser, and the electro-magnetic measure by determining a resistance which would produce the same effect as that produced by repeated charging of the condenser when placed in one arm of a Wheatstone's bridge. In the experiments in 1883, the condenser used in determining the electro-magnetic measure was not the same as that for which the electro-static capacity had been calculated, but one without a guard ring, the equality of the capacity of this condenser and the guard ring condenser being tested by the method given in Maxwell's "Electricity and Magnetism," Vol. I., p. 324.

In repeating the experiments the authors adopted the same method as before, using, however, a key of different design for testing the equality of the condensers by Maxwell's method. The results were very consistent, and practically identical with those obtained in 1883. In reply to the objection which has been made that the capacity of the leads might explain the low value of "v" obtained previously, the authors state that these are allowed for by the way the comparison between the two condensers is made, for the same leads are used in the determination of the electromagnetic measure of the capacity of the auxiliary condenser and in the comparison of the capacity of this condenser with the one with the guard ring; and the capacity of the auxiliary condenser is adjusted until its capacity, plus that of the leads, equals the capacity of the guard ring condenser; and in the electro-magnetic measurements it is the capacity of the auxiliary condenser, plus that of its leads, which is found.

As the use of the auxiliary condenser introduces additional sources of error, they endeavoured to determine the electro-magnetic measure of the capacity of the guard ring directly, using a complicated commutator, which worked both the guard ring and condenser. The first commutator used was one where the contacts were made by platinum styles attached to a tuning-fork; the results obtained with this were not so regular as could be desired, so the tuning-fork commutator was replaced by a rotating one driven by a water motor. A stroboscopic arrangement was attached to the commutator, which enabled its speed to be measured and kept constant. With this arrangement, which worked perfectly, they got values for the electro-magnetic measure of the capacity of the condenser distinctly less than those obtained by the old method. After a good deal of trouble it was discovered that in the experiments by which the equality of the capacities of the guard ring and auxiliary condensers were tested the guard ring did not produce its full effect. When the guard ring of the standard condenser was removed, and the capacity of the auxiliary condenser made the same, the two methods gave identical results; but the effect produced by adding the guard ring was less in the old method than in the new. It was found by calculation that the effect produced by the addition of the guard ring in the old method was distinctly too small, while in the new the observed and calculated effects agreed well together. The new method possesses great advantages over the old one, inasmuch as the auxiliary condenser is entirely got rid of; and since the commutator is a rotating one, its speed can be altered with much greater ease and accuracy than can be done with a tuning-fork. The old method was therefore discarded in favour of the new one.

The following are the results obtained by this method :—

ELECTRO-STATIC MEASURE OF THE CAPACITY, 397·991.

ELECTRO-MAGNETIC MEASURE.

First Set of Experiments.

No. of times the condenser is charged per sec.	Capacity $\times 10^{21}$.	No. of times the condenser is charged per sec.	Capacity $\times 10^{21}$.
64	443·427	64	443·298
32	443·571	55	443·478
48	443·523	42	443·443
80	443·459		

Mean, 443·457.

Second Set.

64	443·043	55	443·766
48	443·097	48	443·378
32	443·378	32	443·646
80	442·950	16	443·672
64	443·686	80	443·163

Mean, 443 377.

Third Set.

64	443·369	80	443·530
32	443·257	55	443·835
48	433·770	64	443·401

Mean, 443·527.

The mean of all the observations = $443·454 \times 10^{-21}$.

The means of the observations for different speeds are given in the following table :—

No. of times the condenser is charged per sec.	Capacity $\times 10^{21}$.	No. of times the condenser is charged per sec.	Capacity $\times 10^{21}$.
80	443 275	42	443·443
64	443·370	32	443·463
55	443 693	16	443·672
48	443·442		

These agree very well together, the greatest difference being about one part in 1,000.

Taking $443·454 \times 10^{-21}$ as the electro-magnetic measure of the capacity, the value of "v" is 299·58.

* Abstract of a Paper read before the Royal Society, on March 27th.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

To night) FRIDAY, April 25th.

INSTITUTION OF CIVIL ENGINEERS.

7:30 p.m. Students' Meeting. Paper to be read: "Some Applications of Electricity in Engineering Workshops." By C. FREWEN JENKIN, B.A.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "The Shapes of Leaves and Cotyledons." By the Right Hon. Sir JOHN LUBBOCK, Bart., M.P.

SATURDAY, April 26th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture: "Colour and its Chemical Action." By Captain W. DE W. ABNEY, R.E., F.R.S.

TUESDAY, April 29th.

INSTITUTION OF MARINE ENGINEERS.

7:30 p.m. Paper on "The Churchill Governor." By J. D. CHURCHILL.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be further discussed: "The Application of Electricity to Welding, Stamping, and other Cognate Purposes." By Sir FREDERICK BRAMWELL, Bart., F.R.S. Paper to be read (time permitting): "The Barry Docks." By JOHN ROBINSON, M.Inst.C.E.

WEDNESDAY, April 30th.

SOCIETY OF ARTS.

CIVIL AND MECHANICAL ENGINEERS' SOCIETY.

7 p.m. General Meeting.

8 p.m. Ordinary Meeting. Lecture: "Photographic Lenses." By T. R. DALLMEYER.

ROYAL MICROSCOPICAL SOCIETY.

8 p.m. Conversazione.

CITY AND GUILDS OF LONDON INSTITUTE:

OLD STUDENTS' ASSOCIATION.

8 p.m. General Meeting, at Finsbury Technical College. Paper to be read on "Electric Traction." By A. RECKENZAUN, Member.

THURSDAY, May 1st.

ROYAL INSTITUTION.

1:30 p.m. Annual Meeting.

3 p.m. Tyndall Lecture: "The Heat of the Moon and Stars." By Prof. C. V. BOYS, F.R.S.

INSTITUTION OF MECHANICAL ENGINEERS.

7:30 p.m. Ordinary General Meeting. "Presidential Address" by JAMES TOMLINSON. Paper to be read: "Report upon Trials of Three Steamers, 'Fusi Yana,' 'Colchester,' and 'Tartar.'" By Prof. A. B. W. KENNEDY, F.R.S.

FRIDAY, May 2nd.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "Théophile Gautier." By WALTER H. POLLOCK, M.A.

PHYSICAL SOCIETY.

5 p.m. Papers to be read: (1) "The Distribution of Flow in a Strained Elastic Fluid," by C. A. CARUS-WILSON; (2) "Photographs of Rapidly Moving Objects;" (3) "The Oscillating Electric Spark," by Prof. C. V. BOYS.

Digitized by Google

The Electrician.

Published every Friday. Price Fourpence; Post Free, Fourpence Halfpenny. Editorial, Publishing and Printing Offices:

SALISBURY COURT, FLEET ST., LONDON, E.C.

Telephone No. 2714. *Telegrams:* "ELECTRICIAN NEWSPAPER, LONDON."

All Communications to be addressed to "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN."

All letters intended for insertion in "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. Subscribers should receive their copies by the first post on Friday morning.*

"THE ELECTRICIAN" *is on sale at the railway bookstalls throughout the United Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices as above.*

SPECIAL NOTICE.

Owing to the increase in the number of pages of "THE ELECTRICIAN," in order to partly cover the increased postage, we have been compelled to revise the rates for Foreign Subscriptions, which are now as follows:—

	3 months.	6 months.	12 months
For Foreign Parts and Colonies:—	s. d.	s. d.	s. d.
Within Postal Union	6 6	12 6	24 0
Aden, Borneo, Ceylon, China, India, Japan, Java Labuan Mozambique, New Caledonia, Persia, Philippine Islands, Siam, Transvaal, and Zanzibar	7 6	14 6	28 0

The rates for the United Kingdom remain as follows:— 5 0 ... 10 0 ... 19 6

TO ADVERTISERS.

"THE ELECTRICIAN" *offers exceptional advantages to Advertisers.* **It has the largest circulation of any English Electrical paper, and circulates all over the World.**

Particulars relating to Advertisements will be promptly forwarded on application to the office.

TRADE ADVERTISEMENTS *intended for the current issue must be handed in not later than First Post on Thursday morning.*

SMALL PREPAID ADVERTISEMENTS *(for Rates see page xv.) are accepted up to 4:30 p.m. on Thursday.*

TECHNICAL PRINTING.

"THE ELECTRICIAN" PRINTING AND PUBLISHING COMPANY (LIMITED) *beg to inform Electricians, Electric Light Engineers, &c., that they make a specialty of Technical Printing, and have a Staff thoroughly acquainted with Electro-Technology. They can, therefore, promise Accuracy and Despatch in the Printing of Electrical Catalogues and Electro-Technical Literature generally.*

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.

Royal 8vo, 5s., postage extra.

Early in each year is issued "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK. *The Directory was established in 1883, and the 1889 Edition consisted of more than 600 pages of printed matter. The names and addresses of all persons engaged in the Electrical Industries may be relied upon as accurate. Useful Tables and Electrical Formulæ, and information specially compiled for this work are given, together with popularly-written Biographical Notices of the leading Electricians, Electrical Engineers, &c., accompanied in many cases by Portraits.*

The issue for 1890, which is still further enlarged and improved (making 850 pages), is NOW READY. Orders should be forwarded at once to the Publishing Offices, Salisbury court, Fleet-street, London, E.C.

CONTENTS OF THE CURRENT NUMBER.

NOTES 611
Magnetism in Iron and other Metals.—XV. By Prof. J. A. Ewing, F.R.S. Illustrated. Continued 615
Electric Arc Light Carbons. By O. G. Pritchard. Illustrated. Concluded 616
A New Tesla Alternating Motor. Illustrated 617
Researches on the Reversal of Polarity of Series Dynamos. By M. A. Witz. Illustrated. 618
A Determination of "*v*," the Ratio of the Electro-Magnetic Unit of Electricity, to the Electro-static Unit. By Prof. J. J. Thomson, M.A., F.R.S., and G. F. Searle, B.A. 619
Meetings of Scientific Societies. 619
WELDING BY ELECTRICITY 620
Reviews 621
The New Westinghouse Alternating Arc-Lighting System. Illustrated 623
Electric Welding. By Sir Frederick Bramwell, Bart., F.R.S. 624
A Street Railway Current Curve. Illustrated 625
The London Chamber of Commerce (Incorporated) 625
The Central London Railway Bill 626
Artistic Electric Light Fittings 628
American Notes 628
Paris Notes 629
Vienna Notes 629
CORRESPONDENCE—
Alternate *v.* Continuous Currents in Relation to the Human Body—H. Newman Lawrence & Otho T. Blathy 629
The Co-Efficient of Self-Induction of a Single Circular Loop.—Otho T. Blathy. Illustrated 630
Street Lighting.—W. Martindale 631
Word-Coining.—"Navis" ... 631
Dynamo and Motor Design.—"The Writer of the Abstract" 631
Trade Notes and Notices 631
PATENT RECORD 632
LEGAL INTELLIGENCE—
Phillips Brothers *v.* Crompton and Co. (Limited) 632
COMPANIES' MEETINGS, &c.—
Eastern Extension, Australasia and China Telegraph Company (Limited) 632
Reuter's Telegram Company (Limited) 634
Great Northern Telegraph Company of Copenhagen ... 634
The Oriental Telephone Company (Limited) 634
The Telephone Company of Ireland (Limited) 635
City Notes, &c. 635
Companies' Share List 636

"THE ELECTRICAL WORLD" OF NEW YORK.

"THE ELECTRICAL WORLD" OF NEW YORK *can be obtained from* "THE ELECTRICIAN" *Office, Salisbury-court, Fleet-street, London, E.C. The Rate of Subscription (payable in advance), is* **£1 1s.** *per annum. Single Copies* **price 6d. each; post free, 8d.**

"ANALES DE LA ELECTRICIDAD" OF BARCELONA.

Published fortnightly. Annual Subscription (Postal Union) Fifteen Pesetas. Single Copies **6d.; post free 7d.** *A Specimen Copy will be forwarded and subscriptions received by* "THE ELECTRICIAN" PRINTING AND PUBLISHING COMPANY, Ltd.

WELDING BY ELECTRICITY.

Even the simplest inventions require genius for their production. Indeed, the test of a great invention seems in most cases to be its simplicity. For seventy years it has been known that if two conductors are brought together in the circuit of an electric current, the imperfect joint between them, offering resistance to the current, grows hot. The arc lamp is one case of this phenomenon, the flame which appears between the parted ends being the mere result of volatilization going on at the incandescent ends of the conducting carbons. Strangely enough, though this fact has been known so long, it does not seem to have occurred to any single soul, until three years ago, that if for the two carbons there were substituted two pieces of metal, and an end pressure applied, the two metal rods would become welded together. Yet such is, in essence, all that constitutes the invention of welding by electricity, one of the latest, but one of the most promising of electrical inventions. Professor ELIHU THOMSON, of Lynn, Massachusetts, himself, like GRAHAM BELL and EDWARD WESTON, of English birth, has brought the new art of electric welding to a high pitch of perfection. That remarkable rapidity of movement which characterises the American people when dealing

Digitized by Google

with new ideas has seized upon the electric welding process, and already has made it the basis of a growing industry. In England the mind of the average man moves more slowly. A British manufacturer hears of a new process; and because it is new he pooh-poohs it. He will wait until someone else has tried it, and lost money over it or gained, as the case may be. Not until he finds his own business suffering does he seriously think about adopting the innovation; at least, too often this is his way. But in a new country, where new things are snapped up, and tried simply because they are new, novel inventions have a much better chance of getting a fair trial on a practical scale; they flourish and become large industries in an incredibly short time. It will hardly be believed that at Lynn there exists already a very extensive factory, employing several hundred hands, not only capable of producing, but actually turning out, one welding machine per week. Yet such is the simple truth.

Nothing could well be simpler than the machinery used in the electric welding process. An alternate-current dynamo furnishes currents at a pressure of about 300 to 350 (effective) volts, and with a periodicity of 50 per second in the number of complete alternations, to the primary circuit of a transformer, which transforms them down to currents of enormously greater quantity at a pressure of only a very few volts, in the secondary circuit. This secondary or working circuit is constituted by stout copper bars, which terminate in massive copper clamps for holding the pieces that are to be welded together. One of these clamps is a fixture; the other is capable of movement to and fro, and is provided with a powerful screw motion, whereby an end-pressure can be put upon the weld. Butt-welding is the only form adopted; butt-welds made electrically being quite the equal mechanically of scarf-welds made by hand. When the two pieces are in place and pressed together the primary current is turned on. Forthwith there is induced in the secondary circuit a current which heats up the metals at the point of contact, and in a few seconds they glow and soften, and can be forced into more intimate union. As the heated surface enlarges, and the joint becomes more complete, more current flows and keeps up the heat. The process is so rapid that the heat has no time to spread. A weld between two bars having a square inch of cross-section is accomplished in 30 seconds, and the red-hot portion does not extend more than two inches on either side of the weld. It would be utterly impossible by any but an electrical method to concentrate so much energy in so short a time upon such a limited bit of material. From 12 to 20 horse-power concentrated for about 30 seconds on three cubic inches of metal are amply sufficient to raise it to welding heat. Such is the latest triumph of electric science.

In the United States electric welding machines are now being employed for a large variety of purposes: for welding iron, brass, copper and steel wire, for jointing telegraph lines, for joining iron, copper, and steel pipes from two to six inches in diameter, for welding wheel tyres, for repairing broken axles, shafts and connecting rods, for welding collars on to axles, for uniting street tram rails, for upsetting bridge eye-bars, and for making stable furniture and portions of carriages and waggons. They have also been used for making L and T joints; for welding brass safety ends to boiler tubes; for brazing in bicycle spokes, and for manufacturing steel link chain. The most astonishing feat appears to be that of splicing, by an accurate weld, wire cable such as is used in wire-rope tramway driving, the cable being fused nearly solid at the joint for about one inch of its length, but not stiffened too much to permit of its passing quite readily over the pulleys of large diameter by which it is driven. Even the operation of riveting appears to be quite within the grasp of this most valuable tool, the rivets being first placed in their respective holes and there heated and compressed *in situ*. Had the engineers of the Forth Bridge been furnished with such implements, they need not have had to carry up and down the structure any riveting furnaces; a small special appliance to be moved from point to point, and a pair of conducting wires to convey the currents, being all that they needed to drive the rivets home. It is quite conceivable that when the next big bridge comes to be built, the whole design will be different from what it would have been had the electric welding machine never been heard of. We commend the subject to the notice of Sir Edward Watkin and to all the would-be builders of high towers and big bridges. Already the possession of this new tool has had an effect on the design of bicycles. At Hartford, Connecticut, a brazing-welder has been in use for nine months, during which period it has been used for about 30,000 operations, such as brazing the two tubular limbs that constitute the driving fork into a special cast-steel socket. Forty such brazings can be made in one hour. No wonder that the managing director of these works has re-designed the entire structure of his bicycles so as to braze or weld electrically as many joints as possible.

Not only are the ordinary operations of welding thus performed, but it is even found possible to perform others hitherto deemed impossible to execute, such as the direct welding of iron to brass, the welding of cast-iron and cast-steel, and the welding to iron shanks of tools made of such intractable materials as Mushet steel and Pfeil's unweldable steel. It is probable that the aluminium industry will be directly benefited; for this material, which it has hitherto seemed impracticable to weld, or even to solder, satisfactorily, either to itself or to any other metal, is now welded electrically with the greatest ease. Indeed, it is impossible to foresee the possible applications to which this new invention may lead. Science has added one gift more to those she has bestowed on mankind; and, like her previous gifts, it is itself the harbinger of more good things to follow from the inexhaustible treasury of her wealth.

REVIEWS.

"Traité Théorique et Pratique d'Électrochemie." By Donato Tommasi. (Paris: E. Bernard et Cie.)

This elaborate work, which deserves the name of encyclopædia rather than that of treatise, is intended for the use of all persons concerned with the numerous applications of electro-chemistry. Although it consists of a series of abstracts of original researches made in various countries during the last hundred years, its aim is not so much to present an historical summary of the progress of the science, as to describe its actual state at the present time. At present there is no book dealing at all adequately with the subject which does not approach it too exclusively from the point of view either of the chemist or of the electrician. There is need for a work dealing with the matter in a more comprehensive way; and it is this need which M. Tommasi has endeavoured to meet. The numerous and important applications of electro-chemistry, such as electro-plating, electrotyping, the deposition of metals, and last, but not least, the storage of energy by secondary batteries, and the theoretical considerations involved in these matters, render the subject so vast that it is not surprising that more than 1,200 pages have been found necessary to describe them. The workers in the fields of both pure and applied science have become so numerous that it is quite impossible to read all that has been done even in one's own special department, unless the results obtained are collected in some convenient form. For this reason encyclopædias of science and its applications are very much wanted;

Digitized by Google

and M. Tommasi's book is, therefore, of great value. The work has been written quite in an unbiassed spirit. The theory of each experimenter is given with the practical results of his research. The reader is left to judge for himself between the frequently conflicting theories of the various workers. The author does not give his own views at all. It is a pity he does not do so sometimes. Each chapter begins without any general introduction to the subject of which it treats, and merely consists of a number of abstracts, without any criticism on the part of the author, or any remarks to smooth the passage from one subject to the next. It is, perhaps, far too much to expect that any one man should be able to properly discriminate between the reliable and doubtful work done in all parts of a subject of such immense range as electro-chemistry; but, all the same, it is to be regretted that this is not sometimes attempted.

The very exhaustive nature of the work will be best indicated by enumerating the twelve sections, or chapters, into which the book is divided. The first section deals with general considerations on electrolysis, and the second with movements produced in liquids by the electric current and with electric migration generally. Chapter III. is concerned with chemical combinations and decompositions produced by electrical means. Chapter IV. is devoted to a general study of the electro-chemical properties of the various elements, and the discussion of the applications of electrolysis to the deposition of various metals, such as copper, nickel, cobalt, silver, and gold. The chemical and physical properties, and the preparation of the various alloys and amalgams, are treated in the next section; and the following chapter deals similarly with mineral compounds. Chapter VII. is devoted to organic chemistry and the formation and decomposition of carbon compounds by electrical processes. In Chapter VIII. general chemical laws and chemical analysis are discussed; and Chapter IX. deals with thermo-chemistry more especially in its relations to electro-chemistry. The following two chapters discuss very fully the conductivity for electricity and heat possessed by solids, liquids and gases; and the concluding section deals with the magnetic, diamagnetic and magnetic rotary properties of different substances. A valuable appendix drawn up by W. W. Webb contains a copious list of researches on electro-chemistry made during the last hundred years. This will be of great use for purposes of reference. A very complete index, consisting of two alphabetical lists, one of authors, the other of subjects, appropriately concludes the book, since much of the practical value of such a work depends on the facility of reference to all researches connected with any particular subject.

The book is characterised by its experimental character, and by the absence of theory and mathematics. It is enriched throughout by numerous tables of valuable data. This is especially the case in the chapter on thermo-electricity. In the fourth chapter, which alone occupies 300 pages, the description of each metal is commenced with a concise table of its physical constants, such as its atomic weight, density, boiling point, melting point, specific heat, its thermal and electric conductivity, tenacity, malleability, and magnetic properties. On the other hand, matters of purely theoretical interest and those of a more practical nature are often thrown together indiscriminately, and there is nothing to guide the reader in choosing the important work from that of more doubtful value. Thus, there are twelve methods described for the production of aluminium; but the Cowles process, although one of the greatest importance, is dismissed in very few words. The work is, moreover, written rather from the chemical than the physical side; and the electrician will be frequently disappointed. Thus, when copper electrolysis is dealt with no mention is made of the researches of Thomas Gray. No theory of the action of primary batteries is given, and no mention whatever is made of secondary batteries. The chapters of most interest to the electrical reader are those dealing with electric conductivity, magnetism, and electro-optics. Here a vast number of numerical results of observations made on various substances have been brought together in an accessible form for the first time.

We can congratulate the author on the production of the most exhaustive and valuable work on electro-chemistry which has yet appeared.

"The Technical Applications of Electricity to Matters connected with Engineering." ("Die Electrotechnik in ihrer Anwendung auf das Bauwesen.") By H. Görges and K. Zickler. (Leipzig: Wilhelm Engelmann.)

The above title is a somewhat too literal translation of that of a recent German book which appears as a supplement to an exhaustive practical treatise on building construction. The subjects dealt with are electric lighting, the transmission of power and electric railways, and the applications of electricity to mining operations. The first two subjects are treated by Herr Görges, the latter only by Herr Zickler.

The work has been compiled for the use of students of engineering, and aims at giving a general, though fairly comprehensive, account of the methods by which electricity is produced and utilised for practical purposes. The authors have therefore omitted everything of a mathematical character, with the exception of here and there an application of Ohm's or Joule's law. They assume, however, that the reader has some slight acquaintance with the fundamental phenomena, such as can be got from the ordinary elementary text-books.

The first part of the book is devoted to a description of the various machines and apparatus used for producing electricity. Dynamos, motors, transformers and accumulators all receive a fair share of attention; and the descriptions are accompanied by illustrations which call for special praise, not only for their originality, but also for the accuracy of their detail. The figures and lithographed plates maintain the same high standard of excellence throughout the entire book. Much valuable space is often saved in the text by the insertion of diagrammatic sketches, showing the different methods adopted by different makers in applying the same principles. For example, there is a good series of sketches showing the shape of the field-magnet and the relative positions of the field-magnet coils and armature in the various types of dynamo. We notice a slight omission in the description of accumulators. The author does not lay sufficient stress upon the fact, though it is afterwards tacitly assumed, that an accumulator can be used with equal efficiency to send any current not exceeding the maximum prescribed value; in other words, that an accumulator is useful as a direct current transformer. Those who are not familiar with the use of accumulators often get hold of the idea that an accumulator is meant to always give a larger current than that supplied to it when charging.

In the second part, where the question of electric lighting is very fully treated, we find the different methods of distribution described in full, and the merits of each fairly discussed. The chapter of examples of electric light installations not only gives details of many large installations, but enables the author to touch incidentally upon several important points which would otherwise not come under the notice of the reader. The same remarks apply also to the third part of the book, in which the transmission of power and the kindred subject of electric railways are considered. The tables which are given of the first cost and working expenses of light installations and electric railways are valuable, as showing the approximate capital required for such undertakings, and they are based upon the careful calculations of quoted authorities. These estimates, however, all refer to the direct-current systems, and it would have made the work more complete if some reliable data had been given by which the relative cost and efficiency of the direct and alternate current systems might be compared, especially in the case of the transmission of power. Perhaps the subject of motors for alternate-current work is as yet not sufficiently developed to enable one to make comparisons of this kind; we notice, however, that no description is given of any of the existing alternate-current motors.

The fourth section, on the application of electricity to mining, has been written, as we said before, by Herr Zickler. It deals in an interesting and detailed manner with the various kinds of fuse used in mining, and the methods by which they are exploded. Some account is given of the many forms of induction apparatus used practically for this purpose. The section concludes with a comparison between the cost of firing mines in the old-fashioned way by a slow-burning fuse a metre long, and by an electric fuse with attached copper wires. He shows that the former method costs about ½d., the latter 2d. per

Digitized by Google

fuse; so that in either case the cost is trifling compared with the amount of stone loosened from the mine. The advantage of the electric method lies in the greater safety of the miner, in being able to fire the mine from a distance sufficiently great to secure him from harm.

The volume before us is one which would commend itself to English readers, not only by the fulness with which the subject is treated, but also by its conciseness, a quality which, alas! is not too often found in German works. It has also the merit of being singularly free from matter of a controversial character. We hope that before long an English translation of it will be forthcoming.

Guide to the Correction of Errors in Code (and other) Telegrams. Fourth Edition. (London: 1, 2, and 3, Salisbury-court, Fleet-street.)

The fourth edition of this valuable aid to senders and receivers of telegrams, although maintaining the same plan as the three preceding editions, has been greatly enlarged, so as to keep pace with the increasing employment of secret or code messages. The first part comprises a list of words, two or more of which, when signalled in Morse alphabet may become identical by the mere variation of the space between the signals—such variation, for example, as that which converts "man" into "mate," "grade" into "grab," and so on. Against each of these words, many thousands in number, is the Morse symbol, and the transformation to which it is liable in course of transmission. The list being prefaced by a complete Morse alphabet and numerals, not only may senders of telegrams judge for themselves the relative safety of alternative words, but receivers may correct such words as have been mutilated or disarranged in signalling. And this is a task which devolves more and more upon the patrons of the telegraph, owing to the almost universal practice of employing words which afford no clue to their identity for the guidance of the telegraph operators. Part II. comprises a much longer list of words which experience or prtacical knowledge has shown to be unsafe for code purposes, either through similarity of signals, identity in sound, or indistinctness of writing. Altogether the volume contains about 70,000 examples; and business men who use the telegraph largely, whether for inland or international purposes, will be fortunate indeed if at some time or other a work of this kind does not prove of invaluable service for deciphering inaccurate telegrams, or safeguarding against the use of words which are specially liable to be rendered inaccurately. J. L.

THE NEW WESTINGHOUSE ALTERNATING ARC-LIGHTING SYSTEM.*

This system consists in operating a constant-current main circuit which passes through converters suitable for the number of lamps to be operated at any one point. The system has been worked out in a very complete manner both as regards the dynamo, the lamps, and accessories.

The dynamo very closely resembles the Westinghouse alternating incandescent machine, but its distinguishing feature is to be found in the construction of the armature. The latter is shown in perspective in Fig. 1, and transverse sections in Fig. 2. It will be noted that in this case the armature coils are not, as heretofore, in the shape of flat coils placed on the periphery, but consist of oblong coils (Fig. 3) which are wound separately, and then by means of a clamping tool are clamped in position around the cores of the armature projections, which are provided with overlapping teeth. After the coils have been placed in position the spaces between the teeth are filled out with wooden wedges, which are dove-tailed and slid in from the side, so that no further fastening is required to keep the coils or the wedges themselves in position. The peculiar construction of the armature with the overlapping teeth has the effect of maintaining the current constant at all loads, so that there is no regulating apparatus whatever required for that purpose.

The armature is built up of thin wrought-iron sheets stamped out to the required shape; and the teeth are so designed, and are of such length, that they slightly overlap the distance between two consecutive pole-pieces, so that one tooth is not out of the field of any one magnet before another enters that field.

* From the *Electrical Engineer* of New York.

At the side of the dynamo there is an apparatus consisting of a solenoid with a single core. It is a short-circuiting apparatus, and its object is to protect the machine from the results of a break in the line. In the continuous-current machine a break in the line is generally followed by the cessation of current in the armature when a series machine is employed; but in this system a break in the external circuit causes the generation of a heavy current in the armature, which, if not prevented, would eventually cause its destruction. To avoid this the apparatus shown is employed, and its function is to short-circuit the armature. By this means the counter electromotive force generated in the armature is such as to cut down the heavy current to the normal strength, so that no dangerous heating of the armature coils can take place. The apparatus is so constructed that an excess of electromotive force generated in the armature, such as would be caused by a break in the line, causes a spark to pass between two points; this allows sufficient current to pass to energize the solenoid, which pulls up its core and makes contact between two points that short-circuit the armature.

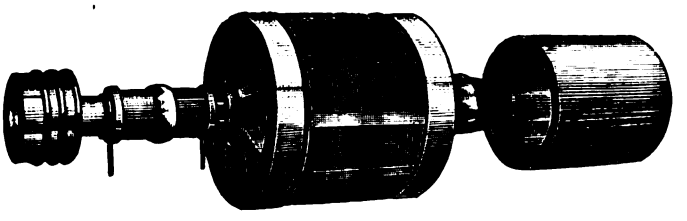


FIG. 1.—The Westinghouse Arc Light Alternator. Perspective view of Armature.

There is still another safety device of the same nature, which consists of two metal points placed opposite each other on the armature shaft and connected respectively to the collector rings. Upon the current exceeding a certain value the spark formed between these two points causes a short-circuiting of the machine, and a consequent cutting down of the current, due to the increased self-induction.

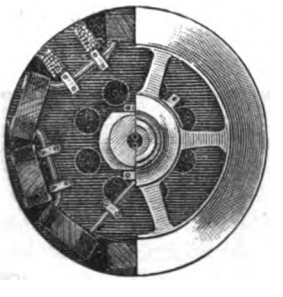


FIG. 2.—The Westinghouse Arc Light Alternator. Transverse section of Armature.

The machines now built and in course of construction vary in capacity from 25 lights to 240 lights, and the table at the end of the article shows their various sizes and capacity. It will be noted that the speeds of these machines are considerably lower than those employed in the incandescent system, and that the number of alternations per second is also far below that of the former, the average number approximating 7,500 alternations per minute, as compared with 16,000 for the incandescent machines. The machines Nos. 2 and 3 are provided with two sets of windings connected to two pairs of collectors, so that two independent circuits can be run from one machine.

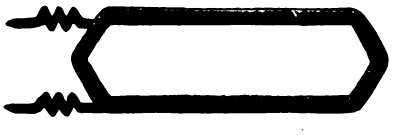


FIG. 3.—The Westinghouse Arc Light Alternator. Armature Coil.

Coming now to the apparatus intermediary between the dynamo and the lamps, we find it to consist of converters which do not, of course, differ in principle from those used in connection with the incandescent system of distribution; but for this particular purpose converters of a peculiar construction are in some instances desirable. In ordinary incandescent systems the primary and secondary of the converter are usually so designed that the ratio of reduction of potential between them is comparatively a high one, usually in the neighbourhood of 20 to 1. In this system,

Digitized by Google

POWER TESTS OF WESTINGHOUSE ALTERNATING ARC SYSTEM.

Load.	Average speed revolutions.	H.P. indicated.	H.P. neglecting engine and shaft.	Amperes in lamp line.	H.P. per lamp.	Apparent watts in lamp line.	Apparent H.P. in lamp line.	Apparent efficiency, per cent.
Engine and shaft	301·3	21·04	.....	.....	.. ...	.....	.....	.....
Dynamo and exciter	302·4	23·40	2·36	.....	.....	.....	.....	.....
Dynamo, short-circuited	293·4	30·90	9·86	.....	.....	.....	.. ...	.....
Dynamo, short-circuited through converters.	300·0	40·56	19·52	.....	.....	.....	.....	.....
Dynamo, converters and 10 lamps	297·8	44·9	23·85	10	2·38	4,660	6·2	26
Dynamo, converters and 40 lamps	291·0	60·6	39·56	10	0·989	18,80J	25·2	63·7
Dynamo, converters and 80 lamps	288·8	85·1	64·06	10	0·801	37,860	50·7	79
Dynamo, converters and 100 lamps	290·5	101·5	80·46	10	0·805	49,150	65·9	82
Dynamo, converters and 120 lamps	285·4	111·5	90·46	10	0·754	58,980	79·06	87

however, a series of converters of various capacities are designed in which the ratio of the primary to the secondary is as 1 to 1, and in others as 1 to 3. The windings in the 1 to 1 converters are evidently identical for the primary and secondary. Though on first consideration this might be considered a curious condition, the reason therefor will become apparent when it is considered that by the employment of such converters no greater potential is admitted to a building in which there is one lamp, for instance, than is required for that particular one, and leaving the same perfectly safe to be handled, as the potential required for each lamp does not exceed 50 volts.

The lamps employed in connection with this system are of two general types, known as the long and short lamps, and designed respectively for outdoor and indoor use. The distinguishing feature of these lamps consists in the fact that they are designed to burn flat carbons whose life approximates to 40 hours in the case of the long lamp, and to a somewhat shorter period in the case of the short lamp. Thus, in the long lamps two carbons are employed, the dimensions of which are 9½in. by 2in. by $\frac{7}{16}$in. In the short lamp the length of the carbon is reduced to 6in. The mechanism of the lamp is very simple, and consists in a rack movement which is regulated by a solenoid in the main circuit, and by another of high resistance, which is placed in shunt to the arc. Both of these are provided with cores built up of bundles of fine wires, so as to avoid heating and to increase their sensitiveness.

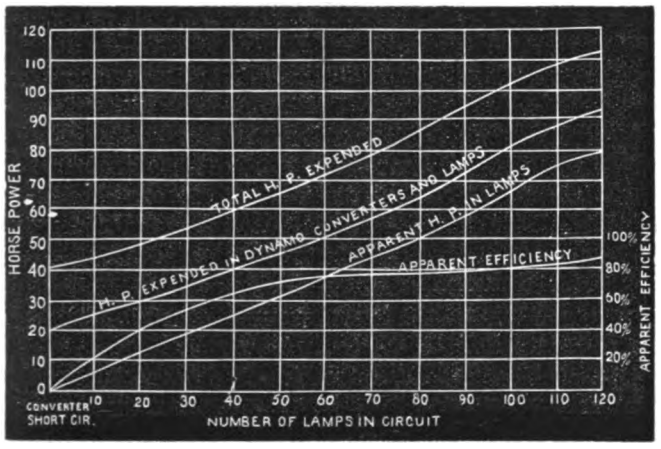


Fig. 4.

There are several accessory devices employed with the system, one of which is a double safety cut-out. This consists of the usual strips of fusible metal, but, in addition, the points which they span are shunted by a fine German-silver wire. It frequently happens that upon the fusing of the usual safety strip, an arc forms at the break, which is apt to travel backward and burn the contacts, and thus ruin the entire device before the arc is broken. By employing the German-silver shunt around these points the fusing of the fusible strip immediately sends the current through the shunt, which at once fuses, breaking into small pieces and forming directly a break of six inches between its terminals—a distance which the arc is incapable of following.

A series of tests have been made on this system, showing its efficiency under various conditions; and for that purpose we give above a table showing the results of a test carried out at the works of the Westinghouse Electric Company in Pittsburgh. These tests were made on a No. 2 30-ampere machine, operating 120 lights. The engine was of the Westinghouse single-acting two-cylinder type, the diameter of the cylinder being 14½in. and the length of stroke 30in. The curves shown in Fig. 4 represent graphically the results given in the table. From these it will be seen that the machine at very light load has a comparatively low efficiency; but beginning with forty lamps up to the full capacity the efficiency rapidly increases until at full load it approximates 87 per cent., and the energy per lamp required is ·75 horse-power.

In further explanation of the action of the machine we may add that the regulation for constant current depends primarily upon the fact that the armature is wound with a sufficient number of turns to produce a high self-induction, and consequently a lag in the current approaching 90 deg. when short-circuited. According to a well-known law, the current lag, as related to the impressed electromotive force, is reduced by the introduction of resistance into the circuit, and approaches coincidence with the phase of electromotive force as its limit. The magnetisation of the field is so related to that of the armature that when an armature pole is opposite to a field pole, and the magnetising effects are in contrary directions, the resultant magnetisation is reduced to a very small amount. These two elements combine to produce an effective cutting of lines of force approximately proportional to the external resistance in the following way:—When the armature rotates with a high resistance in circuit the lag is small, and the maximum current flows in approximate coincidence with the maximum of electromotive force; that is, when an armature pole is an intermediate position between two field poles. The direction of current is opposite to that in the field coils of the pole it is approaching. In other words, the maximum point in the current phase occurs about 90deg. in advance of the coincidence of two poles of similar polarity. A reduction of resistance in the work circuit causes a lag in the current phase, so that the maximum point is reached at an instant in time more nearly coincident with the opposition of similar poles; and when the armature coils are short-circuited and the lag reaches its maximum, the magnetisation of the armature-pole occurs approximately at the time of its passage under a field-pole of opposite polarity. Since the windings of the field and armature are such as to set up approximately equal magnetic potentials in opposite directions, the cutting of lines of force is now reduced to a minimum value sufficient to cause the flow of a normal current through the coils. The current characteristic of the machine can be made to approach as nearly to constancy as can the electromotive force characteristic of a constant potential dynamo with varying current.

ELECTRIC WELDING.*

BY SIR FREDERICK BRAMWELL, BART., F.R.S.

Tolerably correct definitions can generally be given, the lecturer said, of the more commonly-used technical terms, such as "stereotyping," "safety valve," &c.; but he doubted very much whether most people had any clear conception of what was meant by welding. Welding was not fusing or burning; it was the uniting of two pieces of metal by the aid of heat and pressure. The lecturer then quoted from Dr. Percy in order to show how extremely difficult it was to hit off in metals other than the recognised weldable metals—iron, steel, and platinum—the proper welding temperature, and to effect the weld while the metal was at that temperature. The three welds, the scarf, double-wedge, and butt, formerly employed in the making of wheel-tyres, were next described. The heating of the metal to be welded had hitherto been done in the smith's fire, which was in its way a perfect work of art, a grotto of coal with a fire inside it, in which the thing to be heated could be put. This way of going to work was obviously defective. First of all it was dirty; then the heat was not easily regulated; and, lastly, the heat was by no means uniform throughout. The heat was from the outside inwards, and therefore while the external layers of the metal might be much too hot, the inside

* Abstract of lecture delivered at the Royal Institution, April 18th.

Digitized by Google

might be quite "raw," so to speak. The desiderata in welding were (i.) Uniform heating through the entire section ; (ii.) Regulation of the heating ; (iii.) Freedom from dirt ; (iv.) Ability of inspection during heating. All these requirements were practically fulfilled if electricity was used as the source of heat.

In electric welding, the lecturer said, we were only concerned with the strength of the current, and not with its difference of potential. The fact that the heating effect varied as the square of the current was then demonstrated by placing four incandescent lamps in series across a constant potential circuit, and cutting them out successively until only one remained, when it was seen to give a glow far exceeding four times that which it did at first. The fact that different metals possessed different specific resistances was then shown by sending the same current through lengths of copper, iron, and German-silver wire. Another fact to be remembered, said the lecturer, was that the resistance of metals increased with their temperature. The advantage of this phenomenon in connection with welding was then emphasised by the lecturer, who pointed out that it tended to produce the great desideratum, uniform heating ; since the increased resistance of the more highly heated portions of a weld caused the current to seek the cooler portions, and thus a nearly uniform temperature was attained throughout the entire area of the weld. Iron (with its ally, steel), which was the most important of all metals from a welding point of view, was very fortunately situated in this respect, since its temperature-coefficent of resistance was exceedingly high ; the resistance of soft iron wire at 1,000° C. being eleven times its resistance at 0° C.

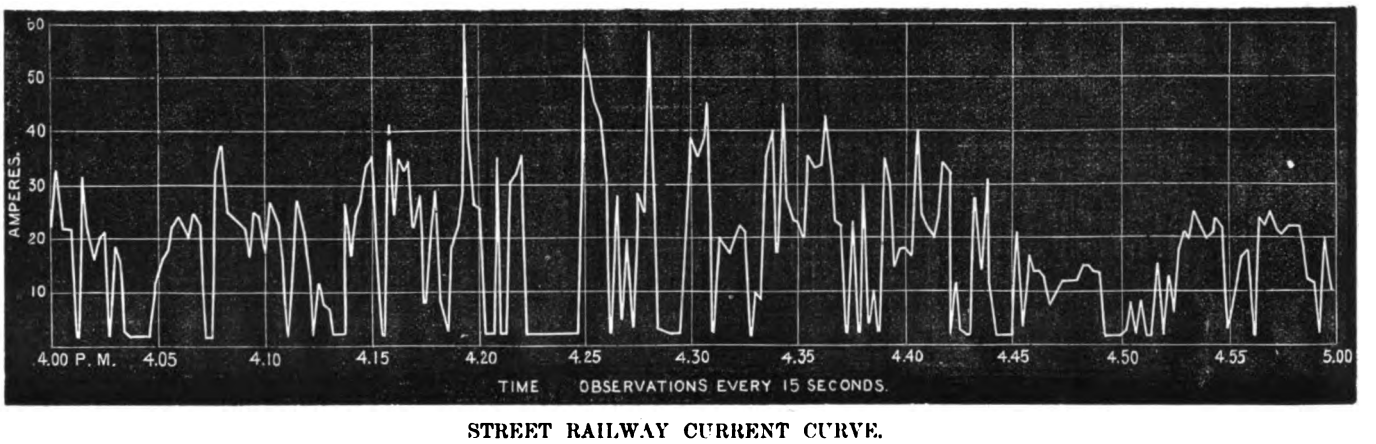
The lecturer then explained how electrical energy was made up of two components—the amperes and the volts. Now the electric welder, he said, required a large current and low voltage, while to transmit electric power without undue loss a small current of high voltage was required. If, therefore, it was impossible to generate the current close to the welder, some instrument was wanted by which we could transform the high-voltage current into one of large quantity and low voltage at the electric welder. Such an instrument was available in the alternating-current transformer, the principle of which was made clear by the aid of experiments with two Ruhmkorff coils, the original source of energy being five primary cells. The five cells were connected to the primary of the first coil, the secondary of which passed through a small incandescent lamp, but without causing it to glow : this secondary was connected to the secondary of coil No. 2, in the primary of which another lamp was placed, and was made to glow brightly. This, said the lecturer, was an example of the way in which a high-voltage and small-amperage current can be used for transmission purposes, and then can be transformed down to a low-voltage and large-amperage current for heating purposes.

Several welds were then effected by a small Elihu Thomson electric-welding machine, the lecturer having previously described the peculiar form of alternating-current transformer used in welding on a large scale, and the methods of regulating the current either by altering the resistance in the exciter circuit of the dynamo, or by using a "reactive coil" (*The Electrician*, August 30, 1889, p. 422), placed in the primary of the transformer. Referring to some experiments which he had undertaken with a view of testing the value of this method of welding, the lecturer stated that he had procured for the purpose a large number of pieces of Farnley round iron, 1⅛in. in diameter and 14in. long. These were sent to the electric-welding works at Fanshaw-street, and on a certain day the operation of welding these was commenced, at 11:45 a.m., and was continued until eighty welds had been made. This was effected by 3:24 p.m., or, allowing for a rest of half-an-hour, three hours and nine minutes, giving an average of a little under two and a-quarter minutes per weld. The smith and hammerman were electricians, and not smiths, so that they laboured under considerable disadvantage. With the object of making direct comparison, portions of the same lot of iron were welded in the ordinary manner by skilled labour. In this case also the work was continued for three hours, in which time forty-four welds were made, or a little under four minutes to a weld. The pieces were then numbered, and sent for experiment to Mr. Kirkaldy's testing works. From these it appeared that the strength of the metal being originally 52,646lb. per square inch, that of the electrically welded pieces (where they broke at the weld) was 48,215lb., or 91·9 per cent. of the original strength ; while in the case of the hand-made welds the corresponding figures were 46,899lb. and 89·3 per cent. As an instance of the complete control which could be attained when welding by electricity, pieces of copper, aluminium, and German-silver wire were welded by the Thomson automatic welder (*The Electrician*, August 30, 1889, p. 422), which automatically cut off the current as soon as the weld was effected.

In conclusion, the lecturer stated that he was of opinion that Prof. Elihu Thomson's great invention would be used rather to effect what might be termed extraordinary welds, in which direction it was so efficient, than in ordinary welding operations ; and that the fact of the existence of such a machine would open up many new uses.

A STREET RAILWAY CURRENT CURVE.

The fluctuations of the ammeter at the power stations of street railways have been much commented on. What these fluctuations may amount to, especially where only a few cars are operated, is most forcibly brought out by the following curve, which we take from the *Electrical Engineer* of New York. The curve represents the ammeter record at the power station of the Sprague electric railway at Brockton, Mass. It gives the readings with three cars on the line, and brings out very strongly the severe conditions which are met with in this kind of work.



STREET RAILWAY CURRENT CURVE.

THE LONDON CHAMBER OF COMMERCE (INCORPORATED).

The annual meeting of the Electrical Trades Section of this Corporation was held on the 21st inst., at the offices, Botolph House, Eastcheap ; Mr. R. E. Crompton in the chair.

The SECRETARY (Mr. R. Kenrick Murray) read the minutes of the last meeting, which were confirmed, and signed as correctly entered.

The CHAIRMAN then explained that it had been decided to increase the number of the committee from 33 to 48 members, the number which was arranged for at the formation of the Section ; so as to get an infusion of new blood into it, and thereby increase its usefulness. The committee, as newly constituted, would therefore consist of the following gentlemen :—

Telegraph Companies (7).

Sir John Pender, K.C.M.G. (Eastern Telegraph Company, Limited).
Mr. J. H. Tritton (Indo-European Telegraph Company, Limited).
The Marquis of Tweeddale (Eastern Telegraph Company, Limited).
Mr. C. W. Earle (West India and Panama Telegraph Company, Limited).
Mr. R. K. Gray (Spanish National Submarine Telegraph Company, Limited).
Mr. H. Weaver (Anglo-American Telegraph Company). (Away.)
One vacancy to fill.

Digitized by Google

TELEPHONE COMPANIES (4).

Colonel R. R. Jackson (National Telephone Company, Limited).
Mr. H. Grewing (Oriental Telephone Company, Limited).
Mr. J. Brand.
Mr. J. W. Batten.

ELECTRICAL MANUFACTURERS AND CONTRACTORS (20).

Mr. R. E. Crompton (Messrs. Crompton and Co., Limited).
Mr. Alex. Siemens (Messrs. Siemens Brothers and Co., Limited).
Mr. M. Immisch (Messrs. Immisch and Co.).
Mr. E. Garcke (Brush Electrical Engineering Company, Limited).
Mr. F. L. Rawson (Woodhouse and Rawson United, Limited).
Mr. B. Pell (Messrs. Johnson and Phillips).
Mr. C. J. Wharton (Messrs. Laing, Wharton and Down).
Mr. W. O. Callender (Callender's Bitumen Telegraph and Waterproof Company, Limited).
Mr. B. Drake (Messrs. Drake and Gorham).
Mr. W. T. Goolden (Messrs. W. T. Goolden and Co.).
Major S. Flood Page (Edison and Swan United Electric Light Company, Limited).
Mr. G. Binswanger (General Electric Company).
Mr. James Swinburne (Messrs. Swinburne and Co).
Mr. James Taylor (Telegraph Manufacturing Company).
Mr. W. L. Madyen (Electrical Engineering Corporation, Limited).
Mr. R. J. Jenkins (Henley's Telegraph Works Company, Limited).
Mr. Paterson (Messrs. Paterson and Cooper).
Mr. Joseph Smith (Electric Construction Corporation, Limited).
Messrs. Spagnoletti and Crookes (not replied).
Mr. Sidney Sharp (Messrs. Sharp and Kent).

ELECTRICITY SUPPLY COMPANIES (9).

Major-General Webber (Chelsea Electricity Supply Company, Limited).
The Earl of Crawford (London Electric Supply Corporation, Limited).
Mr. R. Wallace (Westminster Electric Supply Corporation, Limited).
Mr. R. S. Erskine (Kensington and Knightsbridge Electric Lighting Company, Limited).
Mr. Jos. Crookes (Notting Hill Electricity Supply Company, Limited).
Mr. Robert Hammond (House-to-House Electric Light Supply Company, Limited).
Mr. S. F. Dobson (St. James's and Pall Mall Electric Light Company, Limited).
Mr. H. G. Massingham (Taunton Electric Lighting Company, Limited).
One vacancy to fill.

CONSULTING ELECTRICAL ENGINEERS, AND GENERAL (9).

Mr. J. E. H. Gordon.
Mr. W. H. Preece.
Mr. G. Kapp.
Mr. H. Sherley Price.
Mr. Musgrave Heaphy.
Mr. F. T. Medcalf.
Mr. W. Worby Beaumont.
Mr. H. Lea.
Prof. Geo. Forbes.

The CHAIRMAN concluded by moving their election *en bloc*.

The motion was seconded by Major-General WEBBER, and agreed to unanimously.

Colonel R. R. JACKSON expressed a wish to withdraw his name; but, at the request of Major-General WEBBER and Mr. E. GARCKE, both of whom bore high testimony to the value of his services to the Section, he was induced to continue to serve.

The CHAIRMAN here took occasion to refer in feeling terms to the death of Mr. W. H. Snell, late Editor of *The Electrician*, and remarked that by the demise of that gentleman not only the whole electrical profession, but this Section of the London Chamber of Commerce in particular, in the proceedings of which Mr. Snell took a keen interest, had sustained a great loss. The Chairman then went on to say that it was now his duty to vacate the chair to which they had done him the honour to elect him last year. He regretted very much the fact that he had perhaps somewhat inadequately filled the post; but it was not quite so easy a task as it might seem at first sight. His successor would, no doubt, find it very much easier, because they had got into somewhat better working order than they were at first. They had a very modest bill of fare to put before the members, and there were still a few matters in hand which he hoped would soon be completed. One of the solid things that they had done during the year had been with regard to establishing the British Association screw-thread as a standard type for apparatus and screws; and if they could only get gun-makers and clock-makers, and the screw trade to take up the matter as the Section had done, it would be seen that something had been done towards making the standard popular. Another achievement, which had been his own child to a certain extent, had been the starting of a sort of statistical society for collating electrical statistics; and he hoped that it would result in bearing valuable fruit to the electrical industry. There could be no doubt that they were in want of accurate knowledge of what was being done all over the world in respect of electrical science; and it was to be hoped that if they gave the results of their experience and information to their neighbours, the benefits derived therefrom would be duly appreciated and reciprocated. With regard to the screw gauge question he might say that Mr. Trotter had called on Mr. H. J. Chaney, the keeper of the Board of Trade standards, who had consented to allow comparisons of screws and gauges of the British Association standard to be made at the Standards Office, 7, Old Palace Yard, Westminster, by any person making an appointment with him for that purpose; and who was prepared to consider the matter of making the screw gauge a legal gauge; and it was therefore to be hoped that in the course of next year they would succeed in accomplishing that. Another matter in which Mr. Garcke had rendered substantial service was with regard to the railway rates, as to which they had obtained, with the exception of one or two matters yet undecided and of minor importance, most of the advantages they had hoped to receive. He trusted, now that they had a larger committee, that the attendances at their meetings would be larger than had hitherto been the case, so as to enable them to effectively carry on the useful work in which they had embarked.

Major-General WEBBER expressed his satisfaction at the statement just made by the Chairman. The work that had been done by the Section, as had been rightly observed, had been in directions of a very important character; and if it had not been quite so successful as might have been expected, they must not forget that this was the first year of the existence of the Section, and that a great deal of the time of the Committee had been taken up in organisation and in finding out the different directions in which their labour might be profitably and usefully exercised in the interests of electrical industry. Mr. Crompton had referred to his successor; but he (the speaker) having attended the meetings as frequently as he could, was a witness that no one could be a better Chairman than Mr. Crompton himself, or could take a greater interest in the subjects which were now engaging their attention. He, therefore, would propose that they should unanimously invite Mr. Crompton to undertake the duties of the chair for another year.

Colonel JACKSON said he had great pleasure in seconding the proposal, and paid a warm tribute to Mr. Crompton for the way in which he had fulfilled his duties during the past twelve months.

The motion was carried unanimously.

Mr. CROMPTON, assuming the chair for the second time, expressed his appreciation of the compliment paid to him, and assured them of his intention to do all that he could in the interests of the Section, which he hoped would be instrumental in effecting some useful work in the future.

On the motion of Mr. SWINBURNE, seconded by Mr. BEAUMONT, Mr. E. Garcke was elected Deputy-Chairman, together with Major Flood Page, the other retiring Deputy-Chairman.

Mr. GARCKE, in returning thanks, said that he would willingly assume the duties provided that Lord Crawford, who now retired, did not see his way to resume office.

A discussion on the subject of the labour conciliation scheme followed, in which some of the most prominent difficulties in connection with the subject were set forth by the Chairman, Col. Jackson, Mr. Stephens, Major-General Webber, Mr. Applegarth, and Mr. Trotter.

Colonel JACKSON then proposed, and Mr. R. S. ERSKINE seconded,

"That the thanks of the Section be given to the gentlemen who had elaborated the scheme for the adjustment of labour disputes, and that the Section undertakes to co-operate in the proposed plan of co-operation, and that it instruct its committee accordingly."

The motion was agreed to *nem. con.*; and the Chairman having been thanked for presiding, the proceedings terminated.

CENTRAL LONDON RAILWAY BILL.

HOUSE OF COMMONS.—MONDAY, April 21st.

On Monday last a Sub-Committee of the House of Commons, consisting of The Hon. Walter James (in the chair), Mr. Esslemont, Colonel Bridgeman, and Sir Walter Grey, began an inquiry into the scheme for constructing an underground railway from Uxbridge-road along Oxford-street, terminating close to the Bank of England.

Mr. Pember, Q.C., Mr. Saunders, Q.C., Mr. Freeman, and Mr. Monroe appeared for the promoters; and a numerous Bar, representing some 30 or 40 opponents on the line of route, who opposed on different grounds. The principal counsel were Mr. Pope, Q.C., Mr. Littler, Q.C., Mr. Cripps, Q.C., Mr. Vane, Q.C., Mr. Rose-Innes, Mr. Freeman, Mr. Pollock, Mr. Danckwerts, &c., &c.

Mr. PEMBER, Q.C., opened the promoters' case. He said the length of the line was four miles and a half; the depth at which it would be under the streets of the City averaged about 50ft. The depth was greater towards the City, and it was not unimportant that in very few instances did it pass under buildings, and it was worked in the same way as the Southwark Subway. The capital was £2,500,000, with a borrowing power of £833,000, making a total of £3,333,000; but that was now reduced by some £90,000 intended for a junction with the Southwark Subway, which part of the scheme had now been abandoned. The tunnel would be encased in iron throughout, and "grouted" with blue lias, which would give enormous strength and durability to it, and absolutely prevent again any chance of subsidence. Then there would be hydraulic lifts at the different stations, on a similar plan to those adopted in the Mersey Tunnel and the Glasgow Subway under the Clyde. The speed they expected to attain would be 25 miles an hour; but including stoppages it would be considerably less, about 14 miles an hour, which would take people from the Marble Arch to the Bank in something under a quarter of an hour, or about three times as quickly as by the omnibuses. There would be nine stations, including the two termini, at intervals of about half a mile. There were about 34 petitioners who were afraid of the injury by vibration when the line began to work; but they would have the best scientific evidence of Mr. Greathead, who was assisted by Sir John Fowler and Sir Benjamin Baker, to show that no such thing need be apprehended. The route followed the great thoroughfare through Oxford-street and Holborn to the Bank. As to the mode of construction, it would be different from the other underground railways of London built some 25 years ago, inasmuch as there would be no disfigurement of the streets, the plan proposed being to take sites for stations on the route, and work underground from those stations, bringing up the material and

Digitized by Google

carting it away without any disturbance of the traffic. A further point of difference here would be that there would be no noise heard above ground. There would be no thundering of trains over an iron-floored bridge. There would be no blow-holes, because they worked by electricity instead of steam. There would be no ventilating shafts, because the tunnel was to be double; and the trains in each of the two tunnels would go in one direction continually, so that they might have too much rather than too little draught. The tunnels were 11ft. in diameter. The mode of construction was to push forward an iron shield, so that the earth was supported as the work was carried on; and it was forced forward by an hydraulic arrangement. The great depth at which the work would be carried on in the London clay precluded all chance of subsidence; the line being constructed on such substratum could not injure any one. Then there were 20 petitioners referring to interference with sewers, with gas and water mains, electric mains, hydraulic apparatus, and so forth. Then the Dean and Chapter of St. Paul's were afraid of that structure coming down; but this scheme would have as much effect upon St. Paul's as the tickling of a tortoise's back with a feather.

Mr. JAMES HENRY GREATHEAD was the first witness called. In examination by Mr. Freeman, he said that he was engineer to the City and Southwark Subway, and was responsible engineer for this scheme. Their work would be done at the rate of 15ft. a day; no blow-holes would be required, as in the case of the Metropolitan Railway. There would be no perceptible vibration above ground. The carriages would be entered from the ends, like tramcars, and they would give greater accommodation in height and width than the Metropolitan carriages. The motive power would be electricity, and the generator for the electric current would be at Queen's-road. The current would be carried by a main conductor throughout the whole length of the two tunnels, with a working conductor placed between the rails. The carriages are about half the weight of those run on the Inner Circle Railway—about 80 tons, as against 165 tons. There were some small subsidences near to the Southwark Subway stations, but those stations were made of brick, and in the present scheme they proposed to build iron stations.

In reply to Mr. Pope, Q.C., witness said that the cost of working by electricity would not be more than by steam.

TUESDAY, April 22nd.

On Tuesday, Mr. GREATHEAD was further cross-examined by several of the petitioners upon the alleged injury done to the property on the route.

Dr. HOPKINSON was the next witness. In examination by Mr. Saunders, Q.C., witness said that the London Electric Supply Corporation proposed to transmit 10,000 volts from the Deptford Station. In the case of electric traction the Board of Trade had sanctioned 600 volts, and they were actually using for that purpose on the City and Southwark Subway about 500 volts.

The Board would not sanction electricity being used as a motive power if there was any danger?—No one could come in contact with it unless they were doing that which they had no business to do. Even if there were an accident and they came in contact with a conductor they would experience no harm. He had himself come in contact with 500 volts without suffering any harm.

By Mr. SAUNDERS, Q.C.: There can be no danger from even touching it at the maximum pressure of 600 volts?—I never heard of anyone being hurt at that pressure.

In further examination witness said that the conductor being underground would not be subject to wet, and the insulation would be very good. For the Central London it was intended to use two locomotives for each train, making them substantially the same type as used on the City and Southwark, only a little heavier and more powerful. Engines had been constructed for the City and Southwark, and a contract entered into at so much per train mile, and it was not to exceed ninepence. It would be a much lighter train than is necessary on an ordinary railway. The generating station for the whole of the Central Railway would be at Queen's-road.

What would be the cost of the necessary machinery and plant for working the line?—The estimate for the generating machinery and conductor and locomotives for the train service every two minutes is £275,000.

WEDNESDAY, April 23rd.

Dr. HOPKINSON was then cross-examined by Mr. Pope.—Speaking with reference to the cost of working of electric traction on the Newry line, which the learned counsel put as 88½ per cent., witness said that that would not be a test of what it could be done for, as the Newry Company were not at all dependent upon the proceeds of their line, which was used for bringing coals and goods to their mills.

The remunerative character of the traffic and the working expenses were matters of estimate?—Yes; but we know it pretty well.

Might there not be improvements introduced in the mode of electrical traction?—I do not see where they are to come from.

Cross-examined by Mr. Vane: Supposing the proposed line had formed a connecting line with the City and Southwark, would there be any difficulty in the whole of the electrical power being sent from Stockwell?—No; but it would be undesirable.

Then you mean that the electrical power could be supplied for 4½ miles, but it cannot be supplied for 7½ miles?—No; but it would be more difficult and involve some extra cost. It could not be done without going to a higher electrical pressure, which would have increased the danger. The cost is increased when it is worked at a higher pressure; but, excepting that question of cost, there would be no engineering difficulty. The extra cost of plant would be somewhere about £100,000, and the extra cost of running would be, perhaps, 3d. or 4d. per train mile. Taking 9d. as the estimated cost per train mile on the Central London, if they worked it from Stockwell on the same pressure it would be 12d. or 13d. per mile.

Working it from Queen's-road, then, you would require about 2,500 horse-power to produce the equal amount of electricity?—For ten trains a day, with a 3½-minute service, for 18 hours per day, it would be about 2,000 horse-power. The coal consumed would be about 2½lb. per horse-power.

Is not 3lb. the right thing?—It can be done easily with 2½lb. It would amount to 38 tons for the whole day.

Supposing an accident happened, and the passengers had to get out and walk to the nearest station, would they sustain a series of shocks, which you have described as disagreeable but not dangerous?—They would not get a shock. They would be told not to touch the rails.

Is not the loss 85 per cent., as proved by experiment?—No experiment could possibly have given the result of only 15 per cent. of the power being useful, and 85 per cent. loss. The people who experimented must not have known anything about it. The loss of electric working was double the loss of steam working; but there were other compensating advantages.

Does not the cost of electrical working increase out of all proportion to the increase of speed?—By no means. You may take it that the cost per ton per mile would differ very little for the speed. The cost of electric working per ton per mile is the same at whatever rate of speed.

Comparing the cost of electricity with the cost of locomotive power by steam, would the cost of nine miles an hour be twice as much upon coal, water, and so on, as working by steam?—In my judgment the cost of running the trains on the Central London would be less than running on the Metropolitan. There would be a lighter train for a greater number of passengers on the Central London.

Supposing an equal power existed, equal weight of train, equal speed and equal distance, would not the cost of electrical power at a speed of nine miles be twice as much as steam power?—No; it would be little more than steam.

You do not agree that if the speed was increased up to 15 miles an hour that then the cost between electricity movement and steam movement is very largely increased?—I do not.

If I suggest that it is four times the cost of the locomotive you would not agree?—Certainly not.

Do you happen to know that these very experiments were tried last February on the Manhattan Railway in New York with the express purpose of obtaining what the cost was by electric power and by locomotive power?—I know that experiments were tried, but I do not know the result.

Do not you know that on the report of the experiments being made the Company decided that they could not adopt electrical power, and they adopted steam power?—I do not know; but that would be the natural result if the figures turned out as you have stated.

By Mr. BIDDER: Will your engines alternately pull and push?—That is the proposal.

Do not you know that pushing a train is in direct contradiction to the directions of the Board of Trade?—I do not.

Do not you know that if the engine is in front and is drawing the train the tendency is to keep it on the rails, but if it is pushing it the tendency is to magnify the departure from the curve?—That is a point a good deal discussed among engineers.

But you pull and do not push the train there?—That is so. But supposing the Board of Trade were to take exception to pushing and pulling, the only inconvenience would be a slight loss of time at the terminals. It is simply introduced to avoid the coupling and uncoupling of the engine, and that is a saving of a minute and a-half.

I suppose I am right in saying that the expenditure of electric power and the cost of locomotion is proportionate to the weight of the train?—Yes. The cost of the City and Southwark is 3½d. per train mile, and the cost of the Central London is 9d. per train mile.

Mr. MATHER, M.P., next gave evidence with reference to his firm's guarantee as to the cost of the City and Southwark line. He said that the cost per train-mile was guaranteed not to exceed 3½d.; that would include the cost of the engine drivers and the maintenance of the generating plant, and the coal and the various items which go to generating the current, but it does not include the drivers on the locomotives. Basing these calculations upon their experience of the City and Southwark, his firm had come to the conclusion that they could, at 9d. per train-mile, provide the whole of the plant for the Central London for £275,000. That is for a two-minute service and 18 hours per day. The estimated weight of the loaded train on the City and Southwark was 30 tons, and for the Central London 80 tons. The £275,000 would include the dynamos necessary for generating the current. The pressure is not to exceed 600 volts.

Sir THOMAS FARRER was next called. He stated that he was a resident in Marylebone, and an Alderman of the County Council. The attitude of the County Council towards this scheme was this:—A few weeks ago the Parliamentary Committee of the County Council laid before that body a report in which a great number of arguments were produced against this scheme; and the effect of that would have been to oppose the whole scheme. An amendment was moved by Mr. Bridgman, and seconded by himself, to the effect that the action of the County Council should be confined to protecting their powers and the other interests of the Council, and he believed the amendment was carried without a division. Last February witness presided over a meeting of ratepayers to protest against the Vestry of Marylebone spending money in opposition to this scheme. The idea of the Vestry was that this underground railway would take people from their shops and send them into the City; but even if that were so that objection should not stand in the way of a great public improvement. In the County Council they were having pressed upon them almost daily the necessity of making improved thoroughfares, and when they

Digitized by Google

made these thoroughfares they were done at great cost to the ratepayers. Now, here was a plan by which it was proposed to make a great thoroughfare from the West End to the centre of London without calling upon the ratepayers to pay one penny. Therefore it was in the interest of the County Council and the ratepayers that such a scheme should be carried out.

Sir JAMES WHITEHEAD was also called in support of the scheme. He was speaking individually, and not as the representative of the Corporation. Notwithstanding the opening of Queen Victoria-street, the traffic in the streets of the City was greater than formerly. He would have been an opponent of this scheme if he had thought that it would do any injury to St. Paul's, Holborn-viaduct, or the City sewers.

The Committee was again adjourned.

THURSDAY, April 24th.

The Committee continued the hearing of the evidence for the promoters of the scheme to-day, and several Inspectors of the City and Metropolitan Police were called to speak with regard to the difficulties they had to contend with in consequence of the present crowded state of the streets of the Metropolis, and stated that in their opinion the present scheme was calculated to relieve the existing congestion. A full report of the evidence will appear in our next issue.

ARTISTIC ELECTRIC LIGHT FITTINGS.

We have recently received from a number of well-known makers of artistic fittings copies of their newly-issued catalogues and price lists, the elaborate character of which gives evidence of the great demand for these fittings. Some of the designs show most clearly to what charming combinations the electric light lends itself. It may safely be said that at no time was it possible to call in the aid of the workers in brass, copper, silver, steel, and other metals to such an extent as it now is to assist in the embellishment and ornamentation of public buildings, mansions, offices, &c. Indeed, the only difficulty which is likely to arise is in making a selection from the great variety at the command of intending purchasers. We propose to call the attention of our readers to some of the more striking designs forwarded to us; and as the catalogues from which they are selected are issued by some of the best-known firms in the kingdom, materials and workmanship leave little room for improvement. Lastly, the moderate cost of most of these fittings is by no means their least attractive feature. A large stock is, in nearly all cases, kept.

MESSRS. EVERED & COMPY. (LIMITED).—In the illustrated catalogue of bright brass, bronzed-brass, copper, and wrought-iron fittings for the electric light issued by this firm, every taste is consulted. No. 504 is a plain strong two-light pendant in bright brass, extremely cheap and serviceable, and the wall fittings on the same sheet may fairly be described as of the "useful" sort, while in the group 721, 726, 728, 732, 739, and 741 will be found a series of neat designs. This description also applies to a succession of sheets, upon which are displayed a large number of wall lights in various metals, all of which are very low in price, and many of them most artistic in design and excellent in workmanship. The remaining sheets are devoted to illustrations of electroliers, many of which possess artistic merits of a high order. These fittings can be seen at the extensive show-rooms of the Company, Holborn Viaduct, E.C., a visit to which will well repay intending purchasers.

MESSRS. HULETT & CO. (LIMITED).—In the catalogue recently issued by this firm are illustrated a large number of brackets, ship and ceiling lights, suspension lights, electroliers, standards, portable stands, mirrors, &c., chiefly in brass, copper, and wrought-iron work. A number of these are very elegantly designed. From the brackets may be selected Nos. 236, 237, 217, 246, 247, 249, 200, and 205. These are chiefly in polished copper and brass. In wrought-iron work, the number of brackets and suspensions illustrated offers a large choice. A number of very ornamental ceiling lights are given, and Nos. 300 and 303 are especially well designed. The catalogue contains a large selection of electroliers, the designs of several of which show much taste. No. 443 is a 5-light wrought-iron electrolier: and No. 408 a 3-light, with projecting arms, both of excellent workmanship and design. Nos. 406 and 415 are very ornamental, the former being a 5-light electrolier with repoussé brass work, each arm projecting 12 inches. Messrs. Hulett invite inspection of their large stock at 55 and 56, High Holborn, W.C.

MESSRS. LAING, WHARTON, AND DOWN.—In this firm's catalogue No. 810 is a charmingly-designed four-light suspension electrolier with reflectors, which is admirably adapted for large hotels, restaurants, mansions, &c. No. 855 is a five-light example of the same class, fitted with opal shades, and of very chaste design. No. 893 is a five-light tall standard suitable for reading and smoking rooms, entrance halls, &c. No. 884 is an eight-light ceiling fitting, with holders in shaped metal, and No. 821 on the same sheet of illustrations is a three-light suspension fitting of neat design and fine workmanship. In No. 876 we have a choice specimen of the metal-workers' art in the form of an eight-light pendant with cut-glass bulbs. The above are only a few specimens, of which the catalogue under review contains more than 100 illustrations, including pendants, suspensions, brackets, reflectors, &c. The firm notify that all the patterns included in the catalogue can be had in their new combinations of steel, bronze and silvered, or red metal and silvered. The above can be seen at Messrs. Laing, Wharton and Down's show-rooms in New Bond-street, London, W.

WINFIELDS (LIMITED).—The catalogue of this firm contains 25 large quarto sheets of engravings of various descriptions of pedestals, table lamps and stands, pendants, brackets, ships' fittings, and hall lamps. Only a small selection of table lamps is given, but the designs are neat. Several illustrations of table stands for electric light are given, many being of elegant design. There are a few examples of combination gas and electric light pendants, but the chief feature of the illustrations is a large number of designs in polished brass and copper of electric light pendants. In these great originality and taste are shown. We direct the particular attention of our readers to Nos. 11614, 11609, 11607, 212, in the list of brackets. Messrs. Winfields' show-rooms on Holborn Viaduct, London, E.C., are well stocked.

WOODHOUSE & RAWSON UNITED (LIMITED).—This Company issue a handsomely bound volume, neatly indexed, of brackets, pillars, hall and vestibule lights, reflectors, suspensions, large, medium, and small electroliers, ceiling fittings, &c. Some of the designs are very handsome, and in particular we may mention amongst the brackets Nos. 9,291, 9,182, 10,382, 9,271, and 9,592. Amongst the hall lights are two elegant specimens, Nos. 10,346 and 10,371. A well-designed suspension light is shown in No. 10,335. Amongst electroliers selection is difficult, as all are of excellent design; but Nos. 9,681, 9,637, 10,244, 10,342, 9,770, 10,334, 10,348, 9,292, 9,270, 9,454, and 9,455 are very ornamental. Of ceiling fittings a well-assorted group is shown. Messrs. Woodhouse and Rawson's catalogue is in sheets of photographs, and is got up in the best possible style. The firm's large new show-rooms, at 88, Queen Victoria-street, E.C., contain a large stock of these fittings.

In dealing with the above catalogues, we have not attempted in any way to exhaust the number of the specially excellent designs which they each and all contain. We must refer our readers to the catalogues themselves for a large selection of all kinds of artistic electric light fittings, both for heavy and light wear. Each of the firms under notice have evidently determined to put before the trade their best work. In each case the catalogues are well printed, and no expense has been spared to assist the trade and their clients in the selection of fittings for all purposes. In addition, we may repeat that perhaps the most important feature of all is that the prices quoted are in most cases very low, taking into account the excellence of design and workmanship.

Several well-known firms have catalogues in the press, which we hope shortly to review.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *April* 11, 1890.

National Fast Telegraphing Tournament.—A good deal of interest was excited here by the National Fast Telegraphing Tournament, which came off in Hardman Hall, on April 10th. The event drew together a large audience of telegraphic experts from various parts of the country, and the hall was crowded from one end to the other. Sounders were distributed along the sides of the hall, so that the entire audience could catch the details of the contest. The test for speed employed was the maximum number of words sent in five minutes, the only restriction being that the sending should be fairly readable. Special prizes were offered for the clearest and most finished operation. The result was a surprise, even to the most expert telegraphers; and the first prize was won with the record of 260 words for five minutes—just 52 words per minute. The winner was a Mr. B. R. Pollock, train despatcher of the New York and New England Railroad; and his record showed by all odds the fastest sending that had ever been witnessed in a telegraph contest up to the present time. The speed, in fact, was so great that many of the audience had great difficulty in following it, although some expert telegraphers could keep up with the pace, and pronounced it reasonably clear. None of the other contestants came very near to this speed, although there were

Digitized by Google

several beautiful exhibitions of distinct sending at a speed of about 240. A special class was provided for ladies, and the winner scored 217 words. It will probably be a long time before the speed reached in this contest is beaten. Every signal sent by any of the operators was recorded on a Morse receiver, and was subsequently reproduced, so that it could be studied in detail by means of a very ingenious repeater operated by the record slips.

The Rumoured Electrical Trust.—The rumoured consolidation between the Thomson-Houston and Edison Companies is now authoritatively denied. The rumour was apparently based upon the fact that the Thomson-Houston Company has increased its capital stock to a little over $12,000,000, and this increase was assumed to mean a proposed combination. In the case of the combination ever occurring it is more likely to take the form of a gigantic trust of a somewhat unofficial character, than a direct union of the companies concerned.

Electrical Execution.—Considerable interest is being excited just now by the approaching execution of murderer Kemmler by electricity. There is apparently no escape for him now; and unless he is pardoned, which is scarcely likely to happen, the merits of electrical execution will have been effectively tested by the end of April. The execution is supposed to be a secret one, except for those having it in charge, and for a coroner and his jury. However, on the coroner's jury will be one representative of the New York Associated Press, and one of the United Press, consequently it is not altogether improbable that the public will be treated to an account of the details of the execution, although the publishing of such an account is prohibited by law. It is altogether probable, however, that no very violent legal proceeding would follow the publication by the Associated Press. The execution will be superintended by Mr. Harold P. Brown, who provided the apparatus for the purpose.

Edison Alternate-Current Patents.—A rumour is floating about town that the Edison Company is more interested in alternating currents than might be supposed. It is, of course, well known that the Company possesses certain alternating current patents, but it is more than suggested that these patents will now be withdrawn from the pigeon-holes in which they have reposed for the last few years, and may appear in a more public fashion.

New Vacuum Pump for Incandescent Lamps.—A report comes from Boston of a trial of a new pump for exhausting incandescent lamps. The details of the apparatus have not been made public as yet, but it is not a mercury pump; it is rather an improved air pump of such large size that it can exhaust a large number of lamps with great rapidity, the vacuum obtained being better than ·001. Some of the experiments tried on a large group of lamps were very striking, the current being turned on the lamps in 22 seconds after the pump was started, showing a good vacuum. The pump was operated by steam power. Its cylinders are three in number.

The Molecular Telephone.—A vigorous effort is being made to push a highly improved form of acoustic telephone, called by its inventor a molecular telephone. The Company has formidable financial backing, and are expected to establish several central stations shortly. The instrument used speaks very clearly and distinctly, and operates with considerable success up to a distance of two miles. Whether it will be a formidable competitor of the Bell telephone for small central stations remains to be seen, but for private lines such an instrument is very effective.

PARIS NOTES.

(FROM OUR OWN CORRESPONDENT.)

April 23, 1890.

MM. Mildé et Fils have obtained the concession of a sector bounded on the north and west by the line of the fortifications, from the Porte St. Cloud to the Porte d'Asnières, on the south by the Seine, and on the north and east by the Boulevard Malesherbes, the Rue Royale, and the Place de la Concorde. The length of street to be canalised amounts to 37 kilometres, and the proposed system of distribution will involve a large use of accumulators. Both the Compagnie Continentale Edison and the Société de la Transmission de la Force have obtained extensions of their areas. Trials are shortly to be made at the Municipal Station at the Halles with coke fuel.

M. Lyon-Alemand has laid a proposition before the Conseil Municipal for the erection of a municipal central lighting station at Bercy. The 100,000fr. recently voted by the Conseil Municipal will be spent on the electric lighting of the Rue Auber and the Rue des Halles by incandescents, and of the Quai Valmy, the Quai de Jemappes, the Avenue de Clichy, and the Rue des Apennins by arcs.

The idea of using the upper stories of the Bourse as a central telephonic exchange has been abandoned, and it is now proposed to erect a three-storied building opposite the new General Post Office. There will be three switchboards, each capable of accommodating 6,000 subscribers. It is hoped that the new exchange will be ready by next year.

The Société Française d'Accumulateurs Électriques have brought an action against the makers of the Pollak accumulator. The question has been relegated to a committee of experts.

VIENNA NOTES.

(FROM OUR OWN CORRESPONDENT.)

VIENNA, *April* 21, 1890.

The Testing Department for Electricity of the Imperial Royal Technological Museum has published its report for 1889, which shows that every year it is being made more use of. The principal work has been the testing of conductivity of various sorts of wire, their breaking strain, &c., also the testing of the insulation of cables. This has been principally in connection with the electric lighting of the Volkstheater. In this matter they practically acted as consulting engineers for the institution. They also tested and reported on the electric light installation at the Western Railway Station, and tested and stamped the electric meters in the Court Theatres.

The telephonic development in Austria during 1889 has been very considerable. Apart from the numerous small exchanges opened by the Government in the smaller towns, the existing exchanges have developed rapidly. In Vienna the number of subscribers has increased to 3,000, and the demand is so large that the Vienna Company are enlarging their central station to one of 5,000-subscriber capacity, and are raising a large amount of new capital to run the necessary cables. Even now Vienna has probably the largest number of subscribers in Europe concentrated in *one* exchange. This exchange is beautifully fitted up with a multiple switchboard of the company's own design, made by M. Schäffler, of Vienna, and the service is rapid and good.

In Prag, one of the towns worked by the Telephone Company of Austria, the exchange is fitted up in the same way as the Vienna exchange, with their multiple board for single and double wires. During 1889 the development of the provincial exchanges worked by the above-mentioned English company has also been very satisfactorily. The number of subscribers, exchange and private, has increased to 755 in Prag, 538 in Trieste, 428 in Lemberg, 440 in Graz, 114 in Czernowitz, 152 in Pilsen, 364 in Reichenberg, 160 in Brilitz—total, 2,951, with 6,120 kilometres of wire. In 1889 145,667 telegrams were transmitted by telephone through the Prag exchange.

CORRESPONDENCE.

ALTERNATE v. CONTINUOUS CURRENTS IN RELATION TO THE HUMAN BODY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The experiments of Dr. Harries and Mr. Newman Lawrence, an account of which was given in your issue of April 4th, are certainly very interesting; but the interpretation given to them and the conclusions arrived at are hardly in accordance with modern views and with the teachings of practical experience. It is out of date now to doubt the general correctness of Ohm's law; and, as a consequence, the "resistance" of a body to electric currents must be the same, whether they be continuous or alternating. The apparent discrepancies found were generally mainly due to the effects of self-induction not being taken duly into consideration, and also

Digitized by Google

to comparing with one another results obtained under different conditions.

In the experiments above referred to the human body was balanced in a Wheatstone bridge by coils of wire till a telephone was brought to silence; and it was found that about one-eighth of the resistance necessary to arrive at the balance with continuous currents was necessary with the secondary currents of an induction coil for silencing the telephone. Now this proved nothing else but that the self-induction effect of the resistance coils used was, under the circumstances of the experiments, several times larger than the ohmic resistance of the same; and this is nothing extraordinary with currents varying as suddenly in intensity as these obtained from a Ruhmkorff coil. Part of the difference found with alternate currents as against continuous currents is also accounted for by the great difference in the tensions of the current used. The right way to ascertain the true resistance of the human body with alternate currents would be to submit it to the action of a current of known volts (measured by a Cardew voltmeter) and to measure the intensity of the current traversing the human body. The resistance found with this method would be the same as that measured under similar circumstances with continuous currents. Owing to the difficulty in measuring alternate currents of only a few milliamperes this plan has, to my knowledge, not yet been successfully tried.

A more feasible plan is to arrange a Wheatstone bridge with resistances as free from self-induction as possible. To this end I used for three sides of the same series of from five to ten 10 candle-power incandescence lamps, the fourth side being represented by one of my assistants grasping tightly two stout copper handles. A closer adjustment can be easily performed by exchanging some of the lamps with others of 16 candle-power. With 15 volts alternate current of 50 complete periods per second silence of the telephone in the bridge indicated between 4,000 and 5,000 ohms for the human body; the same values limited the resistance when putting on 30 volts continuous current with a sensitive Deprez-d'Arsonval galvanometer in the bridge. How misleading the comparison with the resistance measured under somewhat different circumstances would be, is illustrated by the same assistant with the same handles being found equal to about 15,000 ohms immediately before and after this experiment when measured with a large Elliot bridge and three volts only.

My seven years' experience with alternate currents tends to show what has been also pointed out by some of the speakers in the discussion, namely, that about double the tension of continuous current can be withstood with about the same amount of discomfort as would be the case with alternate currents.

I hope with this not to encroach upon the valuable space of your esteemed paper.—Yours, &c., OTTO T. BLÁTHY.

Budapest, April 16, 1890.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I desire to say a word or two in reply to the letter of Mr. Henry M. Sayers, on the above subject, in your last issue.

After quoting from the Paper of my colleague and myself, to the effect that to produce muscular fixation with alternating currents a voltage of 6·26 is sufficient (*under the conditions we named, of resistance, position of contact, area of contact, &c.*), Mr. Sayers goes on to say, "Ten times this ought to produce death surely;" and then adds, "This result is, of course, simply absurd in the light of everyday experience." No doubt it is "absurd;" but this *conclusion is that of Mr. Sayers*, and is not in any way justified by what we said in the Paper or after it. It would be just about as reasonable to say that because a certain dose of medicine taken by one individual, *under certain conditions*, produces unpleasant consequences, therefore ten times that dose will kill that same or any other individual *under any conditions*.

In our Paper we distinctly state, in reference to the minimum current which will destroy human life, "We feel sure that no hard-and-fast lines can be laid down on the subject. *Individual resistance and individual sensitiveness vary so much and so unexpectedly* that a current which might be taken with impunity by one person might be more than enough to kill another."

Your correspondent also considers our measurements of resistance open to objection, and says, "Probably the results given by measurements made with alternating current would be different." This form of objection is decidedly amusing, because *we did use alternating currents* for the measurements, as he will find clearly stated if he will take the trouble to look at the Paper again.

I will not presume to combat the fatherly rebuke which Mr. Sayers administers to the Council of the Institution of Electrical Engineers No doubt it will be severely felt by the members of that erring body.

It only remains for me to remind your correspondent that, "in the light of everyday experience," it is advisable—or, at least, it is fair—to read carefully and quote accurately any Paper it is desired to criticise in a public journal.—Yours, &c.

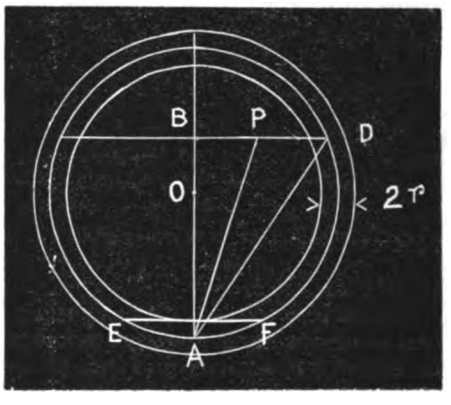
H. NEWMAN LAWRENCE.

The Institute of Medical Electricity,
24A, Regent-street, S.W.

THE CO-EFFICIENT OF SELF-INDUCTION OF A SINGLE CIRCULAR LOOP.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As far as I am aware, the self-induction co-efficient of one single circular loop of wire has up to now been developed only in an approximate form; the following deduction resulting into the exact co-efficient represented by a closed expression will therefore be of some interest.



Let us put

$O A = R$ $\quad$ $A B = x$

$A P = \rho$ $\quad$ $B P = y$

Angle $B A P = a$ $\quad$ Angle $B A D = a'$

τ R, radius of wire.

$d s$, element of wire.

The magnetic force at P due to the element $d s$ is given by

$$\frac{i \cdot d s}{\rho^2} \cos a.$$

The total induction through the circle of radius R (no magnetic material being supposed in the field) is therefore for the unit current,

$$L = \iiint \frac{i \cdot \cos a}{\rho^2} d x \cdot d y \cdot d s,$$

the integrations extending over the area and round the circumference of circle R. Now we have $d y \cdot \cos a = \rho \cdot d a$ and $\rho \cdot \cos a = x$, therefore

$$L = 2 R \pi \int \int_{-a'}^{+a'} \frac{i \cdot \cos a}{x} d x \cdot d a = 4 R \pi \int i \cdot \sin a' \frac{d x}{x}.$$

But $$\sin a' = \sqrt{1 - \frac{x}{2 R}};$$

then $$L = 4 R \pi \int \frac{i d x}{x} \sqrt{1 - \frac{x}{2 R}}.$$

For the space above E F the current i is equal to the total cur-

Digitized by Google

rent in the wire, that is unity. But for the segment between E F and the axis of the wire we have $\frac{x^2}{i} = r^2$. Therefore,

$$L = 4\,R\,\pi\left[\int_0^r \frac{x\,.\,dx}{r^2}\sqrt{1-\frac{x}{2\,R}} + \int_r^{2R}\frac{dx}{x}\sqrt{1-\frac{x}{2\,R}}\right].$$

Integrating and reducing to the simplest form we get

$$L = 4\,R\,\pi\left\{\text{log. nat.}\,\frac{4\,R - r + \sqrt{16\,R^2 - 8\,R\,r}}{r} + \frac{16\,R^2}{15\,r^2} - \left(\frac{16\,R^2}{15\,r^2} + \frac{4\,R}{15\,r} + \frac{8}{5}\right)\sqrt{1-\frac{r}{2\,R}}\right\}$$

This is the exact total induction through circle of radius R by unit current in wire of radius r forming said circle. Developing in series we have, as an approximate expression,

$$L = 4\,R\,\pi\left[0{\cdot}57944 + \text{log. nat.}\,\frac{R}{r} - \frac{2\,r}{R} - \frac{r^2}{24\,R^2} - \frac{r^3}{48\,R^3} - \ .\ .\right].$$

Yours, &c.,

Budapest: April 16, 1890. OTTO T. BLÁTHY.

STREET LIGHTING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: A paragraph has recently appeared in the columns of the daily press as to the lighting of Chelmsford by electricity, in which it is stated that this is "the first town in the country to be lighted throughout by electricity." My Directors would be obliged if you would allow me to correct this statement. The town of Weybridge, in Surrey, is lighted by us throughout by electricity; and as this installation was started on March 1, 1890, Weybridge can certainly claim precedence over Chelmsford. Nearly the whole of Waterford has been lighted by us for nearly three years, and all the principal streets of Taunton (visited last week by an official deputation from the city of London) have been lighted on our Thomson-Houston System for more than three years.—Yours, &c.,

W. MARTINDALE, Secretary.

The Laing, Wharton, and Down Construction Syndicate,
82A, New Bond-street, London, W., April 18, 1890.

WORD-COINING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It does seem strange, considering the progress made in electrical appliances in recent years, that no single comprehensive word has yet been adopted meaning, briefly, motion having electricity as the motive power. May I suggest the following simple yet concise word, conveying a meaning peculiarly its own? That is, the word "motel"—*mot-el* being an abbreviation of the two words motion and electricity, and meaning "to move, or impart motion to, anything using electricity as the moving force." It appears to me a very simple and convenient word, and one that might readily be adapted to the various forms of speech similar to the word "propel." For instance, in the case of the words "electric motor" the word "motellor" may be substituted. The word "motel" being so simple would, if adopted, soon prove itself convenient to the English-speaking community at large. Hoping it may do so, I remain, Yours, &c., "NAVIS."

Devonport.

DYNAMO AND MOTOR DESIGN.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your last issue Mr. W. B. Sayers takes exception to part of my letter published on the 11th inst.; and although I have no desire to be drawn into a newspaper controversy on the subject, I should like to be allowed to reply to his exceptions.

First, as regards the sentence "Laminating the cores has the effect of reducing the divergence," of which he complains, I would point out that what he said at the meeting was "If the core of the armature is well divided and insulated, so as to make the Foucault currents very feeble, the difference between the dynamo and the motor is reduced to a minimum." Your readers may judge whether my statement is or is not a substantially correct version of what he said. He has, in correcting the reporter's transcript, inserted the words, "and non-sparking conditions are fulfilled as regards position of brushes, &c.," after "feeble;" but these did not form part of his remarks.

With reference to the re-written copy, I admit that the *corrected* transcript is practically the same, but the corrections are somewhat numerous and lengthy; in fact, the corrections and the inserted matter amount to about one-tenth of the whole transcript. If the "explanatory note" be included, then the proportion would be about one-quarter.

With the latter part of Mr. Sayers' letter it is not in my province to deal.—Yours, &c.,

THE WRITER OF THE ABSTRACT.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning.*]

SALE BY AUCTION.—Messrs. Wheatley Kirk, Price and Goulty will, on an early date, sell by auction, at the High and Low Mills Forge and Chain Works, Gateshead-on-Tyne, the valuable steel and iron working plant, machinery, and buildings until recently in the occupation of Messrs. Hawks, Crawshay, and Sons (who are retiring from business). Further particulars are given on page xvii.

THE GREAT TOWER IN LONDON.—An advertisement on page xvii. announces that, by permission of the Master and Wardens of the Drapers' Company, an Exhibition of the drawings, plans, and designs submitted in this competition will be held on May 1st, 2nd, 5th, 6th, 7th, 8th, and 9th, free of charge.

METROPOLITAN ASYLUMS BOARD.—The Board has accepted the tender of Mr. C. Bull (Stoke Newington) to supply and fit electric bells from the wards of the Eastern Hospital at a cost of £47. 10s., and to maintain the system efficiently for £8 per annum.

MESSRS. D. HULETT AND CO.—This firm have just issued a very comprehensive catalogue of electric lighting plant and material manufactured and supplied by them. The book is well printed, and contains illustrations, descriptions, and prices of a large quantity of heavy plant, and of measuring instruments, switchboards, switches, safety cut-outs (double and single), roses and wall-blocks, distributing switches and fuse boards, arc lamps and lanterns, carbons, incandescent lamps, lamp-holders, &c. &c. The catalogue also contains some really first-class illustrations of fancy lamp shades, glass globes and shades, &c. &c., and concludes with tables of various descriptions of electric light wires and cables.

THE UNITED ASBESTOS COMPANY (LIMITED).—This Company have recently opened an additional branch house at Provident-buildings, Clare-street, Bristol. The Company now have branch houses at Glasgow, Newcastle-on-Tyne, Liverpool, Cardiff, Bristol, Paris, and St. Petersburg.

ELECTRIC PUMPS.—Messrs. Shippey Bros. (Limited) have on private view a small American high-speed triple-action electric pump, which is being worked by a ¼ horse-power Crocker-Wheeler electric motor, which will pump 1,000 gallons of water per day to a height of 100ft., at a cost of less than 6d. per day for current. Special pumps are being constructed, with automatic regulators, for working on arc circuits of 3, 6½, and 10 amperes. It can also be worked by battery power, for use in country districts, at an esti mated cost of about 1s. per day for chemicals consumed.

OZONISED PRODUCTS.—Mr. Ernst Fahrig, of St. Helen's Ozone Works, Plaistow, is exhibiting a collection of samples of ozonised products at the Permanent Chemical Exhibition in Manchester.

THE EXEMPTION OF MACHINERY FROM RATING.—We are asked to thank the many friends of the movement undertaken by the National Society for the Exemption of Machinery from Rating, for the assistance they have lent. As our readers are probably aware, this movement was brought to a successful issue on the 23rd instant. Machinery users certainly owe their thanks to Mr. Winterbotham, M.P., and the other gentlemen who supported him in Parliament, and the large number of persons who have worked hard to get the injustice complained of redressed. Any of our readers who are interested in this subject can obtain information and assistance from the Society, whose offices are at 22, Buckingham-street, Adelphi, London, W.C.

Digitized by Google

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

1889.

4,125. Rooper. Incandescence electric lamps. (Price 8d.)
5,010. Andersen. Galvano meters. (Price 8d.)
6.384. Goldston. Electric switches. (Price 8d.)
6,544. Goldston. Electric lamps. (Price 8d.)
6.578. Hookham. Arc lamps. (Price 8d.)
6,675. Watel. Electrically-driven fans. (Price 6d.)
6.875. Williamson. Electric bells, &c. (Price 8d.)
7,165. Munro. Electrical distribution of energy. (Price 8d.)
7.856. Johnson and Phillips. Electrical transformers. (Price 8d.)
7.976. De Ferranti. Arc lamps. (Price 6d.)
8.157. Sellner. Electric signalling apparatus. (Price 8d.)
8,213. Lowrie and Hall. Dynamos. (Price 8d.)
8,493. Barber Starkie. Electric cut-outs. (Price 8d.)
8,780. De Facien. Electrical switches. (Price 8d.)
8,815. Thompson (Westinghouse Electric Company). Interrupting electric circuits. (Price 8d.)
15,155. Dickenson. Secondary batteries. (Price 8d.)

1890.

1,050. Bollé (Gutmann). Dynamo-electric machines, &c. (Price 8d.)
1,281. Ernst. Secondary batteries. (Price 6d.)
2,199. Currie. Electro-magnets, &c. (Price 4d.)
2.234. Nutting. Electric arc lamps, &c. (Price 8d.)
2,464. Dorman and Smith. Electric light fittings. (Price 6d.)
2,621. Watel. Electrically-driven fans. (Price 6d.)
2.819. Lutcke. Galvanic batteries. (Price 4d.)
2,825. White. Electrical safety fuses, &c. (Price 6d.)
3,024. Lake (Parkhurst). Electric motors. (Price 11d.)

LEGAL INTELLIGENCE.

Phillips Brothers v. Crompton and Co. (Limited).

In the Divisional Court on Friday last, before Mr. Baron Huddleston and Mr. Justice Grantham, an appeal was heard from a decision by Mr. Justice Lawrance, in Chambers, in a dispute between the above-named firms.

In June, 1889, Messrs. Phillips supplied to the order of Crompton and Co. (Limited) a quantity of electric lighting wire, called "C" wire, to be used in lighting Chelmsford with electricity. Crompton and Co. (Limited) paid the cost, over £1,200, less £54. 17s., and further received some insulated wire to the value of £1,350. In January Crompton and Co. (Limited) issued a writ against Messrs. Phillips for damages, alleging that the "C" wire was not equal to warranty, and in February Messrs. Phillips issued a writ against Crompton and Co. (Limited) for the balance above named, and the cost of the insulated wire, total £1,405. 18s. 8d., applying for judgment under Order 14. Crompton and Co. (Limited) thereupon applied for the consolidation of the actions, and that Messrs. Phillips's claim should be set up as a counter-claim to their claim for damages for breach of warranty. The Master at Chambers refused to consolidate the actions, and gave judgment for the amount named, staying execution until the damage action was tried. The order was appealed against; Messrs. Phillips asking for payment under their judgment, and Crompton and Co. (Limited) for the consolidation of the actions. Mr. Justice Lawrance thereupon directed that upon Crompton and Co. (Limited) bringing £500 into Court within seven days the order of the Master should be set aside, and the actions consolidated, the defendants having liberty to defend; otherwise the Master's order to stand. The money had not been paid into Court, and the application now was by Messrs. Phillips that the order of Mr. Justice Lawrance be valid, and by Crompton and Co. (Limited) that the actions be consolidated and untrammeled by the order to pay £500 into Court.

Their Lordships decided that the actions should be consolidated, costs to be costs in the cause.

COMPANIES' MEETINGS & REPORTS.

The Eastern Extension, Australasia, and China Telegraph Company (Limited).

The thirty-third ordinary general meeting of this Company was held on Wednesday, at Winchester House, Old Broad-street, Sir John Pender presiding.

The SECRETARY (Mr. F. E. Hesse) read the notice convening the meeting, and the minutes of the thirty-second ordinary general meeting, held on October 23, 1889, which were confirmed and signed by the Chairman as correct.

The report of the Directors was taken as read.

The CHAIRMAN: I think I may safely congratulate you upon the report, which I think you will regard as eminently satisfactory (hear, hear). Before, however, asking you to approve of it, I shall, as usual, go over some of the figures in the report, and give you, as I have done on previous occasions, some idea of what we have been doing in the past six months, and what we may possibly be doing in the future. The gross receipts for the half year amounted to £264,103, against £238,854 for the corresponding period of 1888, showing an increase of £25,249. The working expenses have been £73,498, against £71,519 for the corresponding period of 1888, showing an increase of £1,979, which is caused by cable repairs being rather heavier last year than in 1888, and the opening of our new station at Roebuck Bay, Western Australia. The net revenue has amounted to £144,758, against £118,198 for the corresponding period of last year, showing an increase of £26,560 (applause). Comparing the figures for the whole year, the results are as follows:—The gross receipts in 1889 were £520.860, against £478.780 in 1883, or an increase of £42,080. The working expenses in 1889 were £147,271, against £140,816 in 1888, or an increase of £6,455, leaving a net increase of revenue for the past year of £35,625, or nearly 1½ per cent. on the share capital (applause). The usual interim dividends have been distributed during the past year, making, with the dividend proposed to be paid to-morrow, a total dividend of 5 per cent. for the year. It is also proposed to pay a bonus of 4s. per share, or 2 per cent., making a total distribution of 7 per cent. for the year 1889, against 6½ per cent. paid in 1888 (applause). The balance of £58,498 has been carried to the general reserve fund, which now stands at £710,113, made up as follows:—Amount of fund at the end of 1888 was £690,454; to which must be added, interest received on investments during 1889, £22,603; surplus profit resulting from revaluation of spare cable and stores in hand, £23,114; and balance transferred from last year's revenue, £58,494; making a total of £794,665; less cost of partial renewals of Hong Kong-Saigon cable, £15,441; and the further expenditure to date on account of the Western Australian cable, £69,112, thus leaving a balance to the credit of the general reserve fund, as already stated, of £710,113. With regard to the revaluation of stores the practice has been to charge the cost of every repair with the full value of the cable and stores used, and any cable recovered in the operation of repair has always been taken into stock at the lowest possible valuation. Much of this cable has, after overhauling and reserving, proved to be of first-class value, and has been used instead of new cable in subsequent repairs when again the repair account has been charged at a rather high rate, so as to be on the safe side. It has been in the knowledge of the Board that the stores and cable in hand were by this means worth more than the book value, and directions were therefore given that an exact revaluation of these assets should be made. On this being done, a surplus value of £23,114. 13s. 4d. was proved to exist, and the Directors consequently passed this amount to the credit of the reserve fund as previously explained. The net result, therefore, of the past year's working is that the general reserve fund has been increased by nearly £20,000, and £88,000 have been provided from revenue towards the payment of the cost of the Western Australian cable, and the partial renewals of the Hong Kong-Saigon cable, besides paying 7 per cent. to the shareholders (applause). As stated in the printed report, further drawings of the Company's Five per Cent. Debentures have taken place since the close of the year, which, when paid off will entirely extinguish the Five per Cent. (1880 issue), and reduce the Australian Government subsidy issue to £386,500, the original capital having been £640,000. The saving by the first operation will be £5,000 a year. The £320,000 of Six per Cent. Debentures maturing in February, 1891, will be paid off when due by the issue of Debenture Stock or Debentures at a lower rate of interest to be decided by the Board later on. A saving on this account will also be effected, amounting, I hope, to about £6,000 a year. I refer to this now because at the last meeting something was said about these Debentures, and as there is a year still before they mature, I think it right to say that we intend to deal with them on such terms as will, I hope, be satisfactory to the holders of them, and at the same time effect a considerable saving to the Company. The subsidy arrangement with the Government of the Straits Settlements in respect of the Malacca-Singapore-Penang connection terminating last August, and the traffic with Malacca not having sufficiently developed to enable the Company to dispense entirely with assistance from the Government, negotiations were entered into for the renewal of the subsidy, with the result that the Straits Settlements have agreed to give the Company £400 per annum for an additional five years. We consider that satisfactory, because the traffic, though slow, is growing; and from what we know of mining operations going on in that quarter, I look to the traffic being by-and-by very considerable (hear, hear). With regard to the cables generally, all the Company's extensive system is now in good working order (applause); but during the past half-year we have had a good many cables interrupted, and had it not been for the duplicate lines the traffic would have been seriously affected. As it was, New Zealand was entirely cut off from telegraphic communication with the rest of the world for some twelve days, to the great inconvenience of the telegraphing public and the Governments. Under these circumstances, and with a view to preventing, as far as possible, further inconvenience, your Directors determined to duplicate the communication between Sydney and New Zealand without delay; and, with the approval of the Governments of New Zealand and New South Wales, the cable, 1,365 nautical miles in length, has been manufactured and despatched, and is now being laid. Ten days hence I hope that we shall learn that the cable is laid. We have received a telegram from our agent at Sydney, reporting that it is "calm and fine at Sydney and Nelson," so that we anticipate no difficulty in carrying out the work promptly and satisfactorily. I may mention in passing that, as stated at previous meetings, we have had a great deal of controversy with the New Zealand Government in the past. We have come to learn this much now, that a single cable is very uncertain; and so much trust is put in business being conducted by telegraphy, that, unless a continuous system is secured our traffic would not increase as it has done. We have, therefore, guarded ourselves in every way by duplicating wherever it is possible to do so with anything like a show of profit. In regard to the duplication of the New Zealand cable there is a great deal of traffic between New Zealand and

Digitized by Google

Australia, and an increasing traffic between New Zealand and Europe. We therefore did not hesitate for a moment to go to this expense so as to secure that traffic and make the system beneficial and secure for the public (hear, hear). A contract has also been entered into with the Telegraph Construction and Maintenance Company for the renewal of a considerable portion of our important main section between Madras and Penang, at a cost of £102,000. This cable passes over very bad ground in the vicinity of the Nicobar Islands, and interruptions have consequently been very frequent, and at times costly. In 1876 it was broken down for nearly eight months, and since 1880 it has generally been interrupted once or twice every year. Last autumn it was twice interrupted; on the second occasion within a few days of the repair of the alternative cable between Rangoon and Penang. Consequently, we had a narrow escape of a total interruption of the traffic between India and the Far East; and, as this might occur during the south-west monsoon, when it would probably be impossible to effect repairs for at least six months, the Board decided to lose no further time in cutting out the weak portion of the line by laying 650 miles of new cable, from Penang to a point west of the Nicobars. The cable has been manufactured and shipped, and the renewal is expected to be completed next month. The new cable will be laid to the south of the existing line, where we have satisfied ourselves, by special soundings taken by the Company's steamers, that a favourable bottom exists. It will also have a much larger core than the existing line, so that the carrying capacity of the cable, when the remainder is renewed, will be greatly increased. During the last six months, therefore, we have not been idle. We have been spending a great deal of money, but I am perfectly satisfied we have been fortifying ourselves and strengthening the Company. At the same time, we have not saddled capital with the outlay. We think that the policy of paying a steady moderate dividend—a handsome dividend it is in these times—and also fortifying ourselves and placing the business on such a sound footing as to secure that dividend, is one that every shareholder will endorse (hear, hear, and applause). Another International Telegraph Conference will be held in Paris in the course of next month. These Conferences, as you know, are held every five years. I have previously told you that the object of these Conferences on the part of the Governments owning the land lines with their long purses, and who are not responsible to a body of shareholders as we are to you, is to get the tariffs reduced. It is a very remarkable fact that nearly all the Governments of Europe are working their telegraph systems at a loss. I do not think you would be satisfied with me and my colleagues if we came before you every six months, and instead of announcing a good dividend as we do to-day, stated that the balance was on the wrong side. At these Conferences, I may say, however, that we have found on the part of the representatives of the different Governments of Europe a fair desire to meet the cable companies and to admit that the cables do their work quicker and even better than the land systems, and that we are entitled to something more in the way of tariff than the land lines charge; but when they tell us that we are to charge this something more, and that they will charge a lower rate, it is a very nice way of getting hold of our traffic. We must be in a position to do the work, not only better than our neighbours, but as cheaply as they do it, otherwise the traffic will drift away from us. We have no voting power at these Conferences. It is our moral influence that gives us the power we possess; and it requires not merely daily, but hourly, attention there to protect your interests. You may depend upon it that they will not be neglected by us in the coming Conference (applause). At the last Conference we carefully considered our tariffs, and reduced the tariff to Australia from 10s. 8d. to 9s. 4d. The first year we sustained a heavy loss, and the second year we did better, and, as I have stated at previous meetings, we have since entirely made up the loss by this reduction (hear, hear). Whenever we can see that by a reduction of tariff we are going to increase our traffic and benefit our shareholders by enlisting a greater support from the telegraphing public, we shall always be ready to take a broad view, and deal with the matter in that spirit. That will be our policy at the coming Conference (applause). At the same time I am hopeful that we shall not be required to make any great sacrifice. There is a great deal of talk abroad about reduced tariffs and what telegraph companies ought to do; but when I look into the statements, I can only come to the conclusion that their authors do not know anything at all about the matter. As a rule I am very much against answering any statements that appear in newspapers. Newspapers have to produce a revenue to make them pay, and by writing fiction when they are without facts, it may pay them better than if they resorted to truth. I therefore accept with considerable reserve many of the statements which appear in the press; but when a statement is made that we ought to carry telegrams from England to Australia for 1s. a word it makes me think that ignorance is going too far; and as the tendency of the public is to believe anything that will apparently further their interests it is necessary that we should show that those who make such a statement have either deceived themselves, or are trying to deceive the public. (Hear, hear.) I therefore venture to trouble you with a few figures on the subject. The actual cable distance to Port Darwin, where the telegrams are handed over to the South Australian Government for transmission to Adelaide and other parts of Australia is nearly 12,000 nautical miles; and the out-payments alone, without giving any return to the Eastern Extension Company for its large system, amount to 4s. 10d. per word. Consequently, it would be very clever for any one to establish a system at 1s. a word, when, before receiving any profit himself, he would have to pay out 4s. 10d. This shows how absurd such a statement is. I shall take you into our confidence and give you the whole of the details, and show how this 4s. 10d. a word is made up: Germany, Russia, and the Indo-European Company receive 1s. 5d.; Persia, 7d.; Persian Gulf Government department, 11d.; India, 7½d.; Java, 1½d.; South Australian Government, 1s. 2d., making a total of 4s. 10d. Consequently, as the actual outpayments are nearly five times as great as the tariff advocated, and the Eastern Extension Company must receive some remuneration for their part of the work, it is obvious that the most elementary principles of the question have not been appreciated or understood. The statement that, "With reduced rates Sir John Pender thinks the Imperial telegraphs, taken as a whole, would yield a profit of a million a year," was equally incorrect and misleading. The only reference I have publicly made to the subject was at the Colonial Conference in 1887, when I stated that if the Imperial Government guaranteed the cables of the Eastern, Eastern Extension, Indo-European, and South African Companies at the then existing market value, and with the existing tariffs, they would make a profit of something like a quarter of a million. This principle would, of course, involve a lower rate of interest to the shareholders; but, on the other hand, a Government guarantee would greatly improve the position and value of the property in the market (hear, hear). So far, however, the suggestion has not had any practical result. Some two or three years ago, speaking of this tariff system and our connection with the Colonies, I stated that if we could get a Government guarantee it would very much enhance the value of our property, that we would be satisfied with a lower dividend, seeing that it was a Government guaranteed dividend; and we put before the Australian Colonies the statement that if they would guarantee the present income that we receive, they might make the tariff what they pleased. I believe the question has been very much discussed, and that it is considered a fair proposal by the Australians. They say the increased traffic would be so large that the Companies ought to take the responsibility on themselves. I say no; and have told them that, if it is to benefit them so largely and they are so satisfied of a cent. per cent. increase in the traffic, we are quite prepared to take 25 per cent. of the risk, but that the other 75 per cent. ought to be taken by the Colonies. I will give you some other figures, because figures are stiff things to deal with when they are accurate and intended to form the basis of argument in the future. We offered, as I say, to accept one-fourth of the risk; and if the reduced tariff of 4s. a word, instead of 9s. 4d., increased the traffic by 100 per cent., as predicted by some colonists, the amount of guarantee the Governments would have to make up would be quite nominal, namely, £12,750 per annum, which, spread over all the Colonies, would mean a payment of only—£3,731 by Victoria, £3,727 by New South Wales, £1,164 by South Australia, £147 by Western Australia, £2,192 by New Zealand, £1,279 by Queensland, and £510 by Tasmania; making a total of £12,750. Now, gentlemen, with such an insignificant sum demanded from the Colonies, I think our proposal to reduce the tariff from 9s. 4d. to 4s. fully meets the case (hear, hear), and if the colonists are not sufficiently alive to appreciate the great benefits which they would derive from it, we are not to blame. I believe, however, that it is a matter that is rather delayed than abandoned. I should not be at all adverse to coming to an understanding which would improve the value of our property and give additional security to the dividend (applause). With these remarks, ladies and gentlemen, I beg to move:—

"That the Report and Accounts of the Directors now submitted be received and adopted, and that a dividend be now declared of 2s. 6d. per share, together with a bonus of 4s. per share, both free of income tax, payable on the 24th inst., making with the previous distributions a total payment of 7 per cent. for the year 1889."

Mr. F. A. BEVAN seconded the resolution.

The CHAIRMAN invited discussion in the usual way; but no shareholder rising to address the meeting, he at once put the motion, which was carried unanimously. Continuing, he proposed the re-election as a Director of Mr. C. W. Earle.

The Most Hon. the MARQUIS OF TWEEDDALE seconded the motion, which was carried unanimously.

The CHAIRMAN then proposed, and Mr. EARLE seconded, the re-election to his seat at the Board of Sir Thomas Fairbairn, Bart., which was also carried unanimously.

The retiring auditors, Mr. Henry Dever and Messrs. Welton, Jones and Company, were also re-elected for the ensuing year, at a remuneration of £100 each.

Mr. BLUNDELL then proposed a vote of thanks to the Chairman and Directors for their services in the past year, remarking that it was quite clear from the Chairman's statement that the Board's duties were no sinecure (hear, hear). There were probably few undertakings which demanded from the Directors such varied talents and so much attention as a Telegraph Company required.

The motion was seconded, and carried unanimously.

The CHAIRMAN, in acknowledging the vote of thanks, said: Gentlemen, there is no reward more precious to myself and co-Directors than your approval of our policy and our general conduct of the Company's affairs. This is a big concern, and is growing every day. It requires a great deal of attention, sound judgment, and sometimes good temper. I have never been more satisfied with the working of our submarine system than I am at this moment. In the earlier days when I addressed these meetings, I used to say that we had a deal to learn as to repairing cables when they were broken. I have known the time when the breaking of a cable caused me many sleepless nights; but I do not miss my rest now at such an occurrence, because we know where to find the fault, and we can repair it. I look on this property, therefore, as a sound property—as one that is commanding the confidence of the public, and, more than that, as one that the world and the Governments of the world cannot for a moment dispense with. We are, therefore, a great public necessity, which, in our hands, I hope will always be guided and piloted with such a degree of moderation and judgment as will command not only the approval of our shareholders, who are first entitled to our consideration, but also the support and approval of the Governments, who are watching us very closely, and of the general telegraphing public. As long as we do our work well, I doubt very much if anyone can attack us at any point whatever (hear, hear, and applause).

The proceedings then terminated.

Digitized by Google

Reuter's Telegram Company (Limited).

The twenty-sixth ordinary general meeting of the shareholders of this Company was held on Wednesday last at the offices of the Company, 24, Old Jewry; Admiral the Right Hon. Sir John C. D. Hay, Bart., K.C.B., presiding.

The SECRETARY (Mr. W. F. Bradshaw) read the notice convening the meeting.

The report of the Directors and statement of accounts were taken as read.

The CHAIRMAN then said: In moving the adoption of the report, I have to congratulate the shareholders that, on this occasion, the twenty-fifth anniversary meeting of the Company, the Directors have to present a favourable statement. At our last meeting we had rather poor results to show for the year 1888, owing to causes which were then indicated. The year 1889, though not devoid of important events, entailing considerable expense for telegrams, has been, comparatively, a quiet one. There have been none of those little wars which drain our coffers without our deriving extra contributions from subscribers. The quieter state of political affairs has been accompanied by great prosperity in most countries, and the company's revenue has, in consequence, been swelled by extra sources of income. In a business like ours it is always unwise to disclose our affairs too minutely for the advantage of active competitors, whom we have to face in many quarters; and we know our shareholders always appreciate our reticence. We must warn the shareholders that a check to trade means a restriction of commercial telegrams and subscriptions, so that the favourable figures we now submit to you must not be considered as outside the influence of trade fluctuations as well as political affairs. For this reason the Board have thought it prudent to replace two-thirds of the amount which was taken from the reserve fund to make up a 5 per cent. dividend in April last year. The reserve will then stand at nearly £12,000, so that our financial position is strong. With regard to the negotiations with our Continental allies, I am happy to say that, thanks to our Managing Director, who made sundry trips abroad to personally conduct them on behalf of the Company, they have resulted in the conclusion of new agreements for a term of many years. Whilst we are thereby fortified against competition of an international character, we preserve our absolute independence in our own territories. The same independence is enjoyed in their respective countries by the different national agencies with which we are connected by working arrangements. The shareholders will share with the Directors the regret they feel that Mr. Griffiths has felt compelled to resign the secretaryship. He has not only, as original shareholders know, filled the office from the formation of the Company, but was with Baron de Reuter when he started in 1851. After such a long period of service it is not unnatural that Mr. Griffiths under actual circumstances should wish relief from the mere routine duties of his post. But both the Board and Mr. Griffiths were alike disinclined to sever a connection which has been marked throughout with the most cordial relations; and accordingly it has been arranged that Mr. Griffiths, in relinquishing the secretaryship, shall still remain on the staff to give his advice and assistance whenever required. Possibly, after a period of rest he may be able, as he is willing, to resume a more active part in the administration.

The Hon. MARK F. NAPIER seconded the motion, which was carried unanimously.

The CHAIRMAN then moved the re-election to his seat at the Board of the Hon. Mark F. Napier.

Mr. HERBERT DE REUTER seconded the motion, which was agreed to *nem. con.*

Mr. NAPIER having briefly returned thanks,

Mr. T. L. COWARD proposed, and Mr. G. D. WILLIAMS seconded, the re-appointment of the auditors, Messrs. Welton, Jones and Company.

The motion having been agreed to,

Mr. COWARD proposed a vote of thanks to the Chairman and Directors for their successful conduct of the Company's business during the year.

Mr. LOVEDAY seconded the motion, which was carried unanimously.

The CHAIRMAN, in returning thanks, assured the shareholders that the Directors would continue to use their best endeavours to carry on the business of the Company in a satisfactory manner. He was sure that they would rejoice with him in thinking that Mr. Griffiths' services were not lost to the Company entirely; and when that gentleman's health was restored the Board would be again strengthened by his assistance.

The proceedings then terminated.

Great Northern Telegraph Company of Copenhagen.

The following shows the working account of this Company for the year 1889.—The account will be presented to the annual general meeting held at Copenhagen on the 26th inst.:—

	£ s. d.	£ s. d.
RECEIPTS.		
Balance on the 31st December, 1888		41,345 18 9
Traffic receipts	287,448 13 6	
Less loss on exchange	19,619 18 6	
		267,828 15 0
Interest		20,757 4 0
Sundries		6,620 9 10
		£336,552 7 7
EXPENSES.		
Salaries and wages		38,974 10 6
Expenses of stations, offices and agencies		8,602 8 7
Ordinary supervision and maintenance of the sea and land lines, and repairing steamers "H. C. Örsted" and "Store Nordiske"		12,593 0 8
Instruments and cells		2,858 6 4
Maintenance of Company's buildings		443 8 5
Travelling expenses		692 13 5
Bank commission, &c.		3,654 1 3
Sundries		428 5 11
Total expenses		68,246 15 1
Five per cent. interest on debentures	14,250 0 0	
Amortization of 350 debentures	35,000 0 0	
		49,250 0 0
The surplus amount is supposed to be appropriated as follows:—		
Interim dividend paid on 150,000 shares at 5 per cent.	75,000 0 0	
Extra dividend of Kr. 4.50 on 150,000 shares at 2½ per cent.	37,500 0 0	
		112,500 0 0
Addition to the reserve and renewal fund		55,555 11 1
Addition to the pension fund of the staff		2,777 15 7
Remuneration to the Board of Directors		1,500 0 0
Balance carried forward		46,722 5 10
		£336,552 7 7

The Oriental Telephone Company (Limited).

The following is the report of the Directors for the year ending December 31, 1889, to be presented to the tenth ordinary general meeting of the Company, to be held at the Cannon-street Hotel, E.C., on Tuesday next, the 29th inst., at four o'clock:—

The net profit for the year is £7,119. 1s. 11d., after writing off £438. 6s. 3d. for exceptional expenses at three of the Company's branches.

PATENT

SILICIUM BRONZE AND SILICIUM COPPER WIRE.

The best for overhead Telephone and Telegraph Lines,

AND ALL ELECTRICAL PURPOSES.

Hard Drawn High Conductivity Copper Wire.

ROLLED AND DRAWN

PHOSPHOR BRONZE.

PHOSPHOR BRONZE

BEARINGS, BUSHES,

AND OTHER PARTS OF

ELECTRICAL MACHINERY.

SOLE PROPRIETORS of the British, Indian and Colonial Patents,

THE PHOSPHOR BRONZE COMPANY (Limited),

87, Sumner Street, Southwark, London, S.E.

WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

Digitized by Google

Including the sum of £685. 18s. 11d. brought forward from 1888, the amount available for disposal is £7,805. 0s. 10d., which the Directors recommend should be dealt with as follows:—To place £2,000 to the reserve fund; to transfer £500 in reduction of value of stores at branches; £340. 13s. in reduction of amount expended on exchanges on hand, which will then stand at £34,000; and to pay a dividend of 3 per cent., free of income-tax, on the paid-up capital of the Company, other than the vendors' shares, carrying forward £1,237. 2s. 8d. The returns from the Indian companies for the past year show an improvement. The Bengal and Bombay Companies have declared dividends of 4½ per cent. and 3 per cent. respectively on their issued capitals. The Telephone Company of Egypt has declared a dividend of 6 per cent. on its Preferred shares, free of income-tax, and carries forward £1,459. 1s. 4d. The dividends accruing on the shares held by this Company in the above-named companies have been brought into the accounts as usual.

The exchanges at Rangoon and Singapore continue to expand, but those at Madras, Maulmein, Colombo, and Port Louis, make but little progress. A change has recently been made in the management at Mauritius, involving some additional initial expense, which it is hoped may result in some improvement at that branch in the early future. The China and Japan Company has further developed its exchanges at Shanghai and Hongkong. The accounts for the past year show a surplus of £573. 16s. 4d., after paying debenture interest and writing off £300. 15s. 10d. in respect of depreciation and preliminary expenses. In order to provide that Company with more working capital, your Directors have taken up during the current year an additional £500 of its Seven per Cent. Debentures.

During the early part of last year a circular was issued by the Directors to each holder of the vendors' shares, asking them to meet the Board in reference to a re-arrangement of capital account. A meeting was held in response to this circular, but up to the present the negotiations have not resulted in an arrangement.

The Directors who retire at the present meeting are Mr. W. Addison and Mr. G. B. Frost, both of whom being eligible offer themselves for re-election. The auditors of the Company, Messrs. Deloitte, Dever, Griffiths, and Co., also retire, and offer themselves for re-election.

Telephone Company of Ireland (Limited).

Report and statement of accounts for the year ended December 31, 1889, to be presented to the eleventh ordinary general meeting of the shareholders, to be held at the offices of the Company, Dame-street, Dublin, on April 26, 1890:—The number of wires, exchange and private, under rental upon December 31, 1889, was 1,309. On December 31, 1888, the number was 970, being an increase of 339 for the year. This increase has ben caused principally by the opening of exchanges in Cork and Limerick, the number of subscribers to the exchange system in Cork having risen from 24 at the opening of the exchange on January 1, 1889, to 295 on December 31, 1889, whereas for the previous three or four years, during the whole of which time, the telephone service of that city was under the control of the Postal Telegraph Department, the number of exchange subscribers at no time exceeded 30. During the past twelve months, the wires of the Dublin system have been overhauled, a number of iron wires removed, and copper wires erected in their stead. The efficiency of the system has thus not only been fully maintained, but greatly improved by the removal of a prolific cause of faults and occasional breakages caused by the corrosion of the iron wires. The cost has been debited to maintenance. Notwithstanding these exceptional charges, and the general revenue having also to bear the interest upon capital expenditure in Cork, partly unproductive during the creation and growth of the system, the Directors are pleased to state that the net available revenue is sufficient to maintain the dividend of the previous year, a substantial sum being carried forward to the next account; but no addition is made to the reserve fund, because of the exceptional expenditure on the renewal of the wires by the substitution of copper for iron being more than equivalent to the sum usually set aside to the reserve fund. As additional capital is required for the extension of the business of the Company, and for the establishment of the proposed through trunk line connection between the telephone exchanges of Dublin and Belfast, the Directors offered to the shareholders 10,000 New Five per Cent. Preference Shares in proportion to their respective holdings. The subscriptions to these new shares have not been sufficient for the purposes required, and, as the Directors consider that the improved position and increasing revenue of the Company should enable them to raise the necessary funds at an interest not exceeding 5 per cent., they are unwilling to issue the shares as heretofore, as Six per Cent. shares. They therefore propose to submit the following resolution, to enable them to issue debentures to an amount not exceeding in the aggregate the unissued balance of the authorised issue of 75,000 Preference Shares:—

RESOLVED:—"*That the Directors be, and they are hereby, authorised to borrow any sum or sums of money, on such security and terms, as to interest or otherwise, as they may deem fit, and may secure the same by mortgage or by other debentures, or by bonds, or by any mortgage or charge of or upon the whole or any part of any property, funds, assets, or effects of the Company, including uncalled capital, but so that not more than £25,000 be owing at any time, and that no more than £10,000 be issued without the previous consent of a general meeting.*"

Owing to the amalgamation of the United Telephone Company, with the National and Lancashire and Cheshire Telephone Companies respectively, having been carried out by absorption of the United Company and the Lancashire and Cheshire Company by the National Company, it became necessary that this Company should enter into an agreement with the National Company adopting the agreement heretofore existing with the United Company. This agreement has already been signed, but before the same has effect it is requisite to make the alterations in the Articles of Association specified in the accompanying notice; and an extraordinary general meetng will therefore be held at the close of the business of the ordinary meeting for the consideration, and if approved, the passing of the resolution. In the event of this resolution being passed, a subsequent extraordinary meeting will be held for the purpose of confirming it. The amount standing to the credit of the net revenue account, including the balance of £325. 17s. 7d. brought from last account, amounts to £4,459. 4s. 10d., against £4,643. 17s. 8d. for the year 1888. Out of this sum there has been paid an interim dividend upon the Preference shares for the half-year ended June 30, 1889 (£1,071. 12s. 3d., paid in July last), also the interim dividend upon the ordinary shares (£875, paid in August) leaving an available balance of £2,512. 12s. 7d., as shown in the balance-sheet, since reduced by payment (on the 14th January) of the dividend upon the Preference shares for the second half of the year, to £1,392. 17s. 7d., which the Directors propose to allocate as follows:—For the payment of a dividend on the ordinary shares for the second half of the year, at the rate of 1¼ per cent. per annum (absorbing £1,093. 15s.), equivalent to £1. 2s. 6d. per cent. for the entire year, and carrying forward £299. 2s. 7d. to credit of the current year, as against £325. 17s. 7d. brought on from 1888.

In conformity with the Articles of Association, Mr. Valentine B. Dillon and Mr. Hermann G. Erichsen retire at this meeting, but are eligible for re-election.

The auditor, Mr. John M. Kean, also retires at this meeting, but is eligible for re-election.

CITY NOTES, &c.

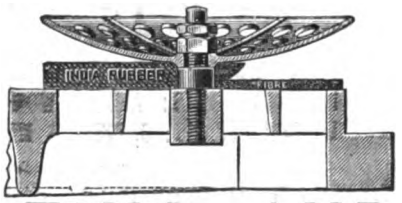
BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The receipts of this Company for the week ended April 18 amounted to £5,208.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended April 18th, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £4,055.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The receipts of this Company for the half-month ended April 15th were £3,593, as compared with £3,742 for the corresponding period of last year.

NEW VALVE

No Rubber, Percha, or Leather.



One-half the price of Rubber or Metal.

FOR CIRCULATING AND AIR PUMPS.

Unaffected by any Lubricating Oils. Does not Expand in diameter. Feed Water may be worked at any temperature Suitable for any shaped guards. Only one quality manufactured.

"12, John-street, Sunderland, 26th Sept. 1885.

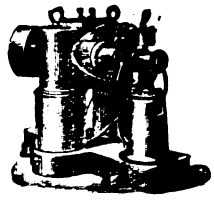
"DEAR SIRS,—In reply to your letter of the 25th inst., the Valves I got from you have done their work well, and ARE AN UNQUALIFIED SUCCESS. I will continue to get them from you as required.—Yours faithfully, JAMES WESTOLL."

For further Testimony and Prices, apply to **MOSSES & MITCHELL, 68-71, Chiswell Street, London.**

Digitized by Google

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Wednesday, April 16.	Price Wednesday, April 23.	Rate per cent. Yielded.	Dividend Due.	Business done during Week ending April 23, 1890. Highest	Lowest.
£			**TELEGRAPHS.**			£ s. d.			
1,770,360	Stock	15/0	Anglo-American	48½ 49½	49 50	5 10 0	Jan., Apr., July, Oct.	49½	...
2,614,820	Stock	30/0	Do. Preferred	82½ 83½	83½ 84½	6 10 2	,, ,,	84½	83½
2,614,820	Stock	...	Do. Deferred	13¾ 14¼	14½ 15	...	February	14⅜	14¼
130,000	£10	3/0	Brazilian Submarine	12⅛ 12⅜	12⅛ 12⅜	5 17 8	Mar., June, Oct., Dec.	12 1/16	12¼
112,900	£100	5%	Do. 5 per Cent. Bonds	100 102	100 102	4 18 0	January and July	...	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	104 107	105 108	4 12 7	June and December.	106½	...
16,000	10	9/0	Cuba Submarine	11 11½	11 11½	7 16 6	February and August	...	...
6,000	10	10%	Do. Preference 10%	17½ 18½	17½ 18½	5 8 1	,, ,,	18⅛	17½
12,931	5	2/4½	Direct Spanish (£4 paid)	3⅜ 4⅛	3¾ 4¼	5 3 6	March & September	...	...
6,000	5	10%	Do. Preference 10%	9 10	9 10	5 0 0	April and October	...	...
60,710	20	3/6	Direct United States	10 10½	10½ 10⅝	6 14 11	Jan., Apr., July, Oct.	10 5/16	10 1/16
380,000	10	2/6	Eastern	14 14⅛	14⅜ 14⅝	4 10 5	,, ,,	14⅜	14⅛
70,000	10	6%	Do. 6 per Cent. Preference	14½ 15	14⅝ 15¼	3 18 8	,, ,,	14 5/16	14⅛
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock	107 109	108 110	3 12 9	May and November.	109	...
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	106 109	106 109	4 11 9	February & August	...	...
250,000	10	2/6	Eastern Extension	14⅛ 14⅜	14⅛ 14⅜	4 14 11	Jan., Apr., July, Oct.	14⅜	14⅛
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	100 102	100 102	5 17 8	February & August	...	...
473,000	100	5%	Do. 5 per Ct. (Austln. Gov. Sub.) Debs. 1900	102 105	103 106	4 14 4	January and July	106	...
179,177	10	1/9	Globe Telegraph and Trust	8⅝ 8⅞	8⅞ 9	5 19 5	Jan., Apr., July, Oct.	9	8⅛
178,992	10	6%	Do. 6 per Cent. Preference	14⅜ 14⅝	14⅝ 15	4 0 0	,,	15	14⅛
150,000	10	5/0	Great Northern	15½ 16	15½ 16	4 13 6	Jan., July, and April	16	15¼
17,000	25	12/6	Indo-European	41 43	40 42	5 19 1	April and October	42	41½
9,000	8	4/0	Reuter's	7½ 7⅞	7⅞ 8¼	5 0 0	April and October	8	7¾
15,609	10	3/6	West African Telegraph	9½ 10⅛	9½ 10½	...	...	...	...
300,000	100	5%	Do. 5 per Cent. Debentures	98 101	99 102	4 18 0	March & September	100½	99⅛
30,000	10	5/0	West Coast of America	9½ 10½	9½ 10½	4 15 3	January and July	9 13/16	9½
150,000	100	8%	Do. Debentures 8%	121 126	121 126	6 7 0	June and December	...	...
88,321	10	nil.	West India and Panama	2 7/16 3⅛	2¾ 3⅛	...	...	3	2⅞
84,563	10	12/0	Do. 1st Preference 6%	11½ 12	11½ 12	...	April and October	12	...
4,669	10	10/0	Do. 6 per Cent. 2nd Preference	14 15	14 15	...	...	...	...
45,181	15	6/0	Western Brazilian	10½ 11	10½ 11	6 17 0	May & November	10 11/16	10⅝
$1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	122 126	122 126	5 11 1	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	99 101	99 101	5 18 10	March & September	...	...
			TELEPHONES.						
224,850	14/0	5%	Consolidated Telephone and Maintenance	½ 5/8	9/16 11/16	...	Yearly	...	...
220,000	£1	3%	Oriental (11s. paid)	¼ 3/8	¼ 3/8	4 8 3	...	...	...
80,000	5	3/0	National	5⅛ 5⅜	5⅜ 5⅝	...	June and December.	5⅝	5 1/16
55,000	5	2/0	United River Plate	4½ 5	4½ 5	...	January and July	...	...
			ELECTRICITY SUPPLY COMPANIES.						
555,000	5	...	London Electric Supply	2⅝ 2¾	2⅝ 2¾	...	...	...	...
500,000	10	...	Metropolitan Electric Supply (£6 paid)	5½ 6	5½ 6	...	...	5⅝	5½
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
190,248	3	...	Brush Electrical Engineering	2¼ 2⅜	2¼ 2⅜	...	...	2 7/16	2⅜
353,478	5	7%	Edison and Swan United	...	...	...	...	...	...
409,000	10	...	Electric Construction	9⅜ 10¼	9⅞ 10¼	...	...	...	...
140,000	2	...	Elmore's Patent Copper Depositing	5 5½	4⅞ 5⅛	...	...	5⅜	5
41,600	10	10/0	India Rubber, Gutta Percha & T'l'graph Work	18 19	18 19	5 5 3	February & August	18½	...
78 949	5	6%	Swan United (£3. 10s. paid)	4½ 5	4⅜ 5	4 3 11	...	4 3/16	...
57,350	12	30/0	Telegraph Construction and Maintenance	44 46	44 46	5 3 11	March and July	45¼	44½



Before Ordering!

ELECTRICAL PLANT & ACCESSORIES

(Statter's) WRITE FOR THE FOLLOWING PAMPHLETS TO THE (United)

ELECTRICAL ENGINEERING CORPORATION, Ld.

PLANT WORKS: WEST DRAYTON, near LONDON.
FITTINGS WORKS: ALBERT WORKS, 36, ALBERT EMBANKMENT, S.E.
LONDON OFFICES: 3, PRINCES MANSIONS, VICTORIA STREET, WESTMINSTER.

"ELECTRICAL DISTRIBUTION."—Commercially considered, with Estimates.

"MACHINE DRIVING BY ELECTRICITY."—The Uses of Electro-Motors for Traction and Stationary Purposes.

"THE TELPHER SYSTEM OF CHEAP TRANSPORT," for Minerals, Goods and Passengers.

"ELECTRICAL SUPPLIES."—Prices and Particulars of the most approved Electrical Appliances

ELECTRICAL PLANT ON VIEW.

Digitized by Google

THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 624.—Vol. XXIV. FRIDAY, MAY 2, 1890. Price Fourpence.

NOTES.

The novel lightning protector which was exhibited at the Institution of Electrical Engineers on Thursday last, and which we illustrate in the present issue, is the latest outcome of Dr. Lodge's remarkable researches on electrical oscillations. While it compares favourably with other lightning protectors in simplicity of design, there can be little doubt of the many theoretical advantages it possesses. The very striking experiment in which sparks were obtained between two adjacent portions of a thin wire shunting a short piece of thick copper, through which an oscillatory current was passing, conclusively establishes Prof. Lodge's main contention that discharges of the nature of lightning do not always choose the path of least resistance; and that consequently lightning-rods, although good conductors in the ordinary sense, may offer a dangerous impedance to a lightning discharge. Admission of this fact is quite consistent with the view, to which Dr. Lodge willingly subscribed, that practical experience shows that a very large measure of safety is secured by the use of lightning protectors constructed on present lines.

The protector itself consists of a number of spark gaps joined in parallel by means of coils of wire, whose object is to offer impedance to the discharge, and thus induce it to jump the gaps. The most rapidly oscillating currents will spark across the first gap, while the slower ones will choose the succeeding gaps, so that the discharge is rapidly sifted of its most dangerous ingredients, and the small portion which is conducted round is insignificant. The impedance offered by the coils, although negligible for telegraphic currents, is enormous for such rapid alternations as occur in lightning discharges. The protector will no doubt be able to compete with the excellent ones already in the market, and we may expect it to be used in future, not only, in conjunction with one of the others, for submarine cables, where the immense interest at stake renders it advisable to adopt every possible precaution against accident, but also for electrical instruments employed in telegraphy.

Incidentally, Dr. Lodge referred to a much-neglected matter deserving the attention of electricians, namely, the almost total absence of lightning protectors from electric lighting circuits. The letter of Mr. Sayers, published in our correspondence columns this week, is very opportune in this connection, since it relates some slight damage suffered by the insulation of leads in consequence of a lightning flash. The subject is an important one to consider now that mains are laid in such complex network under the streets.

In one of his experiments, Dr. Lodge used a protector consisting of two parallel discs of brass connected with the two terminals of the protected galvanometer. The capacity of the shunted condenser thus formed relieved the instrument of the dangerous effects of the electrical oscillations. The anomalous results obtained when the two plates of this plate protector were just touching were curiously similar to those obtained by Prof. Fitzgerald with his oscillation detector used in his recent lecture at the Royal Institution. Dr. Lodge suggests in explanation of these phenomena that an electromotive force is generated between the plates whenever a spark passes, and the shunted galvanometer is in consequence affected. Prof. Fitzgerald connected his galvanometer by long thin wires to the two knobs of the Hertz resonator, and observed an irregular deflection whenever there was sufficient resonance to cause a spark. It is to be hoped that the two phenomena will be further studied. They are very similar, and are possibly due to the same cause.

The suggestion that Faraday would have detected electrical actions within his electrified cage if he had used a galvanometer instead of electroscopes is another interesting example of the new light which recent experiments are throwing on old facts. The impedance offered by the cage to the passage of rapid oscillations would, according to Prof. Lodge, effectually stop all but comparatively slow vibrations; and these, although capable of affecting galvanometers in consequence of their magnitude, would be quite incompetent to affect electroscopes on account of their low tension.

The Paper on Electric Traction, read before the City Guilds Old Students' Association by Mr. Reckenzaun on Wednesday last, contained a most valuable collection of statistics, referring more especially to the amount of power required to electrically drive a car under different conditions of the line. A very interesting series of curves was exhibited, detailing the results actually obtained in Philadelphia on an experimental track about 1,000 yards in length, and containing several gradients and curves. No less than 230 journeys round the track were performed, and the connection between the driving current and the time is exhibited on the curves. An idea of the amount of labour involved

Digitized by Google

may be gathered from the fact that readings of the ammeter were taken every three or four seconds. Among the points more especially dealt with were the effect of snow and rain in modifying the tractive power required, and the economy brought about by skill in driving and the use of regulating apparatus. The author concluded by referring to several points attention to which would effect economy in electrical traction. An animated discussion followed, in which the varying conditions of electric traction on the Barking and Stratford lines and in collieries were referred to. The Paper and resultant discussion, which we hope to publish in our next issue, teemed with useful information, and form a valuable addition to electric traction data. The Old Students' Association is to be congratulated on securing such a highly practical Paper.

MR. DAFT, who was the first to assert the possible increase of adhesive power between the wheels and rails when an electric current was made to flow across the contact, has recently criticised Mr. CROSBY'S experiments to which we referred in our last issue. While agreeing with Mr. CROSBY that the effects are probably inappreciable with currents usually employed on electrical railways, Mr. DAFT still maintains his view that with the heavier currents he was formerly in the habit of working with, the effect is a very powerful one. The unsatisfactory nature which we have already alluded to of experiments made on a stationary car whose wheels are made to skid on the rails is pointed out by Mr. DAFT, who considers that in consequence Mr. CROSBY'S investigation is not at all conclusive. The subject is of sufficient interest and importance to render further experiments desirable, and it is to be hoped that Mr. DAFT will be able to follow the matter up.

THE Bill to amend the Electric Lighting Acts, which was brought in on Monday last by the LORD ADVOCATE, relates solely to Scotland. Across the border they suffer from an *embarras de richesses* in the matter of local authorities. A district, it seems, may be blessed at one and the same time by a Town Council, by Police Commissioners, and by Gas Commissioners. When the time arrived to apply for Provisional Orders the question naturally arose as to which of these three bodies should undertake the task, the general feeling being in favour of the Gas Commissioners doing the work wherever possible. To clear up this point is the object of the LORD ADVOCATE'S Bill. The schedule of Scotch local authorities annexed to the Act of 1882 is repealed, and another is substituted for it; and by Section 2 it is enacted that where the district of any Police Commissioners or Town Council is also within the jurisdiction of any Gas Commissioners, the latter may be appointed by the former as local authority for the purposes of the principal Act. We shall, therefore, soon have an opportunity of observing how electric lighting flourishes when managed by those intimately connected with the manufacture and distribution of gas.

IN his evidence before the Select Committee on Friday last it will be noticed that Sir BENJAMIN BAKER stated that they intended on the City and Southwark line to connect the motors direct to the axles. The absence of gearing is, of course, *per se*, a decided advantage; but it would be interesting to know the size and weight of the motors.

THE Paper read by Prof. RÜCKER at the meeting of the Physical Society on the 18th inst. was one of the most interesting and important communications presented to the Society for a long time past. The causes of the variations of magnetism on the earth's surface are still involved in mystery; and, indeed, the enormous magnitude of the secular variations forced CLERK-MAXWELL to the conclusion that we are not yet acquainted with one of the most powerful agents in Nature. A distinct advance in our knowledge has now been brought about by Profs. RÜCKER and THORPE, whose admirable work in connection with the Magnetic Survey is well known. They have apparently succeeded in tracing local variations in magnetic deviation to the influence of the magnetism of the geological strata in the neighbourhood.

A DESCRIPTION of Mr. BENEST'S gripping-grapnel for submarine cable work will be found in another column. Its principal utility would be when the ship was working near the broken end of a cable, which might slip over the prongs. Even in such cases, however, which do not occur so very frequently, the loose end generally twists around the cable on the other side of the grapnel, and so prevents slipping. Where a bight of cable is hooked it appears to be agreed amongst experts that it is an advantage to have the grapnel render under the cable, especially if there is any current; and if a cable were somewhat tender the extra strain caused by gripping and holding on to one part of it would certainly increase the chance of parting. Patents have been taken out for cutting and holding grapnels; but, so far as we know, Mr. BENEST'S is the first for holding only, and it would no doubt be an advantage for repairing steamers to carry one of these grapnels for use in special cases.

IN his plain-spoken address on "Fire Risks due to Defective Installations," recently delivered at Glasgow, Prof. JAMIESON emphasised two points which are still somewhat neglected by electrical contractors, namely, joints and cut-outs. Although it is, perhaps, too much to expect that the same care will ever be bestowed on electric light wire joints as is customary in the case of submarine cables, it is certainly desirable that this important work should receive greater attention than heretofore. Prof. JAMIESON, we are glad to see, is no advocate of that profuse use of cut-outs which is apparently considered by some to be the universal panacea. He even ventured to hope that the day would come when cut-outs would be entirely dispensed with. However, since cut-outs are used, it would be as well to extract the maximum of usefulness out of them. This desideratum, we need hardly observe, is not attained in an installation like that alluded to by Prof. JAMIESON, in which the same sized cut-out was used throughout.

THE Edinburgh Exhibition was opened yesterday with great success, and there was a large assemblage of spectators. The British exhibits are more forward than is usually the case, but

Digitized by Google

the foreign exhibits are somewhat backward. After the presentation of the address the DUKE OF EDINBURGH walked through the Machinery Hall, and expressed himself much gratified with all he saw.

Samarcand.—The local authorities at Samarcand propose to light the city by electricity.

Bromley.—A committee has been formed at Bromley, Kent, with a view to forming a syndicate for the electric lighting of Bromley, Bickley, and Chislehurst.

Society of Arts Conversazione.—This Society's *conversazione* is fixed to take place at the Natural History Museum, Cromwell-road, South Kensington, on Friday, June 27th.

Royal Society.—Amongst the Papers down for reading at the Royal Society yesterday was one by Dr. Hopkinson, F.R.S., on the "Magnetic Properties of Alloys of Nickel and Iron."

Indian Telegraph Department.—Colonel H. A. Mallock has been succeeded in his post of Director-General of Indian Telegraphs by Mr. W. R. Brooke, formerly Deputy Director-General.

Electric Lighting Acts Amendment Bill.—A Bill to amend the Electric Lighting Acts, 1882 and 1888, was brought in and read a first time in the House of Commons on Monday night.

Electric Traction in Mexico.—According to the *Courrier du Mexique*, the first electric railway in Mexico has just come into operation. The line connects Laredo with Nuevo-Laredo, and runs across the Rio Bravo.

Celluloid.—The Deutsche Celluloid Fabrik has recently introduced perforated celluloid plates for holding the active material of accumulator plates. It has been found to satisfactorily resist the action of sulphuric acid.

Alzano (Italy).—The first alternating current motor has been set up at Alzano Maggiore, where we recently announced the opening of a central station. The motor drives a centrifugal pump, and according to *l'Elettricita* works very satisfactorily.

Sunderland.—The Board of Trade have decided that, having regard to the objection lodged by the Corporation, they will not give their consent to the application of the Sunderland and District Electricity Supply Company for an electric lighting Provisional Order.

An Electrical Competition.—The Société Belge d'Électriciens announces that a prize of 500fr. will be awarded to the author of the best manual of electricity suitable for foremen and electrical artisans. The works, which must be in French, are to reach the secretary of the society not later than May 1, 1891.

Chelmsford.—On Wednesday last a deputation, consisting of the chairman and members of the Wimbledon Local Board, accompanied by Mr. Preece, paid a visit to Chelmsford in order to inspect the new light. Mr. Preece and the members of the deputation expressed themselves much pleased with what they saw.

The Brazilian Submarine Telegraph Company.—In our advertisement columns will be found the numbers of the 153 debentures of £100 each which were drawn on Friday last at the offices of this Company. These debentures will be paid off at par on July 31st next, at the Alliance Bank, Bartholomew-lane, E.C.

Railway Station Lighting.—From the *Elektrotechnischer Anzeiger* we hear that the railway stations at Bamberg, Regensburg, and Würzburg, will be lighted by electricity. At Bamberg 71 arcs and 736 incandescents will be required, at Regensburg 100 arcs and 818 incandescents, and at Würzburg 136 arcs and 847 incandescents.

The Wynne System of Urban Electric Traction.—We have received a small pamphlet setting forth the advantages claimed for Mr. Frank Wynne's system of electric traction (see *Electrician*, February 28, 1890, p. 427), and pointing out some of the defects, electrical, mechanical, and otherwise, inherent to the storage-battery, overhead and slot systems.

The Lighting of Gas Lamps by Electricity.—The Universal Gas Lighting Company of Jersey City (U.S.) have a mile of street lamps equipped with burners which are lighted and extinguished by electricity. The current used for this purpose is furnished by the electric light company, and the system has worked satisfactorily under very trying circumstances.

Barnsley.—At the last meeting of the Town Council the Park and Lighting Committee reported that part of Messrs. Robinson's woodyard had been fixed upon as the site for the proposed municipal central station, and that the terms quoted by the manager of the gas company for renewing the contract for lighting the public lamps had been sent back to the company.

Trial of the Manager of an Electric Light Company.—According to a telegram from New York, the evidence at the trial of Mr. Charles Pierce, local manager of the Brush Electric Light Company, on a charge of manslaughter, showed that the fall of an electric wire across Eighth-avenue, which resulted in a man's death, was purely accidental, and Mr. Pierce was acquitted.

Paddington Vestry.—The Board of Trade has refused to recognise the legality of the proceedings of the Vestry on Tuesday last week with regard to the selection of a Company to supply Paddington with the electric light.—Notices have been sent out for a special meeting of the Vestry to be held on Tuesday, May 29th, thus giving the month's notice required by the Board of Trade.

Lightning at Limassol.—On March 26th a sudden severe thunderstorm passed along the south coast of Cyprus, at Limassol. The port flagstaff (wood set in concrete) was struck and partially splintered. Within a few paces of the staff stand the Government offices, a high block of buildings, intersected with iron rain-water canals and pipes. A few paces further on is a very high minaret, with metal cap.

Manufacture of Shells by Electric Welding.—According to the *Electrical World* Lieutenant W. M. Wood, of the United States Navy, who is on leave of absence, and associated with the Thomson Welding Company, has devised a process for welding together the head and butt of shells by means of electricity, thus avoiding the long and costly process hitherto in vogue of boring out the solid metal.

Execution by Electricity.—The Philadelphia correspondent of *The Times* states that the United States Court at Syracuse, New York, has granted a writ of *habeas corpus* for Kemmler, whose execution this week by electricity was expected at Auburn prison. The writ was granted because the Constitution prohibits cruel and unusual punishments. It is returnable for June 17th, thus postponing the execution.

Artificial Gutta-Percha.—We are informed by Dr. Purcell Taylor that he has succeeded in making a new insulating material, having all the properties of gutta-percha. The new substance is very tough and elastic. A piece of iron covered with this "Purcellite" was, he states, hammered out flat, then bent and twisted until it broke, without even cracking the covering. The cost is said to be considerably less than that of gutta-percha.

Aberdeen.—The scheme which is being promoted by the Gas Committee of the Town Council for the utilisation of the water in the Loch of Skene for the production of the electric light has been remitted to Mr. Smith, the gasworks' superintendent, to report on. It is believed that a sufficient amount and fall of water could be obtained to produce the electricity required to supply the restricted area to be scheduled at the outset.

Institution of Electrical Engineers.—The students of the Institution met last Friday at the Sanctuary, when Mr. Ernesto Cirla read a Paper entitled "Lightning Conductors according to Modern Theories." Mr. Sydney Sharp took the chair. In the discussion which followed, the Chairman, Messrs. Barton, Wightman, Bone, Parson, and Müller took part. At the next meeting, to be held May 9th, Mr. Müller will read a Paper on "House Telephones."

Electric Tanning.—The use of electricity in tanning is not a modern idea, if a correspondent of a New York daily paper

Digitized by Google

is correct, who says the Persians have for ages believed in the efficacy of electricity in the preparation of leather. The Persians, it would seem, have been in the habit of exposing their leather on high places, especially on Mount Elwend, near Hamadan, and they affirm that lightning is a valuable agent in the curing of leather.

Lectures on Medical Electricity.—Dr. Tibbits will deliver a course of lectures on "Massage and Electricity," at the West End Hospital for Diseases of the Nervous System, Paralysis, and Epilepsy, 73, Welbeck-street, at 5 p.m. upon the first Tuesday in every month, except August and September. Tickets of admission, for which no payment is required, will be issued to medical men upon application by letter to Dr. Tibbits, 68, Wimpole-street, W.

Chatham.—The committee appointed by the Chatham Board of Health to consider the application of the Chatham, Rochester and District Electric Lighting Company for the substitution of 42 for 21 years as the period at which the authorities could, under the Provisional Order, purchase the undertaking, have come to a conclusion which is in every way satisfactory, the Company's request being acceded to provided the Board of Trade will agree to the alteration.

Cardiff.—The Brush Company have issued a circular to their Cardiff customers, informing them that in consequence of the rules of the Board of Trade in regard to overhead wires, and of the decision of the Corporation of Cardiff not to consent to their application for a Provisional Order, they have no alternative but to close their lighting station. Next year they intend to renew their application for a Provisional Order, and trust then to obtain the consent of the Corporation.

Electricity in Engineering Workshops.—A Paper on this subject was read on Friday evening last at a students' meeting of the Institution of Civil Engineers, by Mr. C. Frewen Jenkin. The author gave a description of several workshop appliances driven by electro-motors, namely, a portable drill, driven by a one-horse power motor, an electrical tube-cutter for cutting tubes out of boilers, an electrical travelling crane, and a magnetic clutch, suitable for the gearing on the crane.

Hawick.—At a recent meeting of the Town Council, it was decided to reply to a communication from the Scottish House-to-House Electric Lighting Company to the effect that the Council would sanction the introduction of electric works in Hawick on condition that the Council should have the power to take over the works on payment of the outlay with the addition of 16½ per cent. at three years, 22 per cent. at seven years, and 30 per cent. at any time up to fifteen years, subject to depreciation.

Preston.—At the last meeting of the Town Council, on the motion of Alderman Satterthwaite, the Council passed a resolution assenting to the application by the Lancashire and Cheshire House-to-House Electric Lighting Company (Limited) to the Board of Trade for powers to light with electricity the borough of Preston. He explained that a short time ago they granted permission to a similar company, and the Streets and Buildings Committee had no objection to the Company named being placed on the same footing.

National Telephone Electrical Society.—On the 18th ult. Mr. Percy F. Currall read a Paper on "Batteries" before this Society, in which he discussed the merits of the various cells adapted for telephone purposes. Mr. W. Johnston read a Paper on the subject of "Galvanometers," on the 25th inst. The members discussed the question at great length, the principal instrument coming under notice being the D'Arsonval-Deprez, and the improvements recently suggested in this instrument by Messrs. Ayrton, Sumpner, and Mather.

A Chronological Chart.—We have received from Messrs. Sotheran and Co. a most elaborate chronological chart of the line of descent of the Royal Family of England, drawn up by Mr. Ilius A. Timmis, M.Inst.C.E. As the chart commences about 1,000 years back with King Egbert, it will be seen that it is of a comprehensive character. The work is adorned with Royal arms and crests, and under each Sovereign's name there is a brief *résumé* of the events of each reign. The compilation of this chart must have involved considerable labour and skill.

The Ferranti System in France.—The Ferranti system appears to be meeting with considerable success in France. The Compagnie Nationale d'Électricité has at the present moment Ferranti machines in operation at the Paris Municipal station, at Nancy, Rethel, Vierzon, Sens, Melun, and Hâvre, and concessions have just been obtained at Nimes, a town of 70,000 inhabitants, and at Troyes (Aube), a town of 65,000 inhabitants. Some successful public tests were also made a few days ago at Paris with an arc lamp designed by M. O. Pattin, which it is intended to run in connection with the Ferranti system.

Mica.—While the National Electric Light Association is still endeavouring to have the duty removed from copper, the owners of mica mines in North Carolina and New Hampshire are trying to induce Congress to place a 35 per cent. *ad valorem* duty on imported mica. The immense quantities of this material now used in the manufacture of electrical machinery and apparatus makes this a matter of considerable importance to American electrical manufacturers. Mica is now on the free list; and the proposed tax, says *Modern Light and Heat*, would cost one of the principal electrical manufacturing companies over $25,000 annually.

Prague.—The city of Prague claims to have been the scene of the first Industrial Exhibition ever held, namely, that inaugurated in 1791 in honour of the coronation of the Emperor Leopold as King of Bohemia. The centenary of this event is to be fittingly celebrated next year by a similar Exhibition, a great feature of which will be the section devoted to electrical inventions of Bohemian inventors, such as Pollak, Pulnj, Zenger, &c. The Exhibition will be lighted by 350 arcs and 650 incandescents. Luminous fountains, as at Paris, will be worked. Over 1,000 horse-power will be used for electrical purposes, the greater part for the transmission of energy.

Robbery of Accumulators.—About a month ago it was discovered that 38 accumulators, each weighing 33lb., had been stolen from the Théâtre des Variétés, at Paris. An inquiry was immediately instituted, but without result. A few days ago, however, says *l'Electricien*, a letter was received by the manager of the theatre announcing that the missing accumulators would shortly be forthcoming, and a few hours afterwards they arrived on a cart. The driver professed himself unable to give any information other than that he had been asked by some unknown individuals whom he had accidentally met in the street dragging the cells along in a truck, to take the accumulators to the Théâtre des Variétés.

Leicester.—The special committee appointed by the Council on November 26th last to consider the question of the present provision for telephonic communication in Leicester, and to report to the Council as to what means could be adopted for improving the same, report that they have been in communication with the National Telephone Company in reference to the facilities offered by that Company and the charges made by them. The committee find that the scale of charges for membership of a local exchange would be considerably below the present scale of the Post Office system, and are of opinion that it would be an advantage if the National Telephone Company would connect Leicester with their system, and recommend that the Council should give all reasonable facilities if the Company should decide to do so.

Junior Engineering Society.—On Saturday last a large party of "Junior Engineers" visited the Deptford station of the London Electric Supply Corporation. Great interest was displayed in the 1,500 horse-power Ferranti alternator, and in the Ferranti cable, large quantities of which were to be seen in the various stages of manufacture. A special feature of the Junior Engineering Society, which was formed in June, 1884, and now numbers close upon 100 members, are the visits paid by the Society to engineering and other works of interest. Visits were made last year amongst other places to the Central Institution, the City and Southwark Subway, and the Paddington Station installation. Candidates for admission to the Society must not be over 26 years of age, and must be engaged in the engineering or allied professions.

Digitized by Google

Municipal Electric Lighting Orders.—On Thursday last week a deputation from a large number of Town Councils and other local authorities attended at the offices of the Board of Trade with reference to the Model Order recently issued for municipal authorities. The objections of the local authorities to the Order had been formulated at a meeting in the Westminster Palace Hotel, and they were placed before the Board of Trade officials *seriatim*. The objections were of minor importance, and the amendments suggested by the deputation were accepted by the Board of Trade. A discussion arose as to the appointment of electrical inspectors. Under clause 29, a Court of Summary Jurisdiction may, on the application of any consumer, or of the undertakers, appoint inspectors. It was finally agreed that the Board of Trade should make these appointments. After all their objections had been discussed the deputation withdrew.

Electrical Engineering at King's College.—Great efforts are being made by the Council of King's College to meet the growing wants of the age in the direction of electrical engineering. The engineering department of this College has always had a high reputation; but now, thanks to the munificence of Lady Siemens, a new laboratory for electrical engineering, to perpetuate the name of her distinguished husband, and to be called the "William Siemens Laboratory," is to be constructed and fitted with every modern electrical appliance. Through the kindness of the well-known engineers, Messrs. Davey, Paxman and Co., of Colchester, the Council are enabled to equip a fine engine and boiler room with all the machinery requisite to provide the necessary power, and it is hoped that by this means the whole College will ultimately be lighted by electricity. A new chair of electrical engineering has been established, and the first Professor has been appointed, namely, Dr. John Hopkinson, F.R.S., the President of the Institution of Electrical Engineers, than whom no better selection could be made to undertake the direction of such a laboratory. It is hoped that the new arrangements will commence with the October Session.

The Lighting of the City.—On Tuesday last a special meeting of the Commissioners of Sewers was held to consider the applications for Provisional Orders by the London Electric Supply Corporation, the Metropolitan Electric Supply Company, the Brush Electrical Engineering Company, and the Laing, Wharton, and Down Construction Syndicate. Mr. Pannell moved that the Commission should not consent to the application of the London Electric Supply Corporation and the Metropolitan Electric Supply Company. These two companies had failed to come to terms, so they had no alternative but to oppose their applications. The motion was agreed to. A letter was then read from the London Electric Supply Corporation, complaining of unfair treatment in connection with the allotment of areas. Mr. Pannell said this Company was still unprepared to accede to the two salient points on which the Commission rigidly insisted, the sliding scale and the purchase clause. In two or three days, when the other contracts were absolutely decided on and sealed, this Company would have an opportunity of tendering on the same terms for the remaining area. At the same meeting, the Streets Committee reported relative to the recent inspection of the electric lighting system at Taunton, submitting also a report from Mr. Preece. The report was ordered to be printed and circulated.

The Agitation among the Telegraph Clerks.—In the House of Commons on Thursday last, in reply to several questions with regard to an official circular relating to meetings of officers of the Post Office, Mr. Raikes said what had been done relaxed the rule of the service on the subject of meetings outside the Post Office building for the discussion of official questions, and did not make the rule more stringent. The conditions on which Post Office servants were now allowed to meet were—(1) that ample notice be given to the local post office authority such a meeting and where it is proposed to hold it; (2) that the meeting will be confined to Post Office servants, and to those Post Office servants only who are directly interested in the matter or matters to be discussed; (3) that an official shorthand writer be present if required by the authorities. Mr. Raikes said that his wish was to be accurately informed as to the grievances of the telegraphists, and therefore he thought it desirable that a shorthand writer should be present at these meetings to furnish an authentic report of the proceedings. On the same day a deputation from the clerks of the Central Telegraph Office had an interview with Mr. Raikes at the General Post Office to present a memorial embodying their complaints against the present regulations of the service. Mr. Raikes, in reply, promised that the subjects dealt with by the deputation should receive the consideration of the Departmental Committee to which the grievances of the provincial clerks had been referred.

The Board of Trade and Electric Lighting Orders.—On Monday night, in the House of Commons, in reply to a question by Mr. Waddy, Sir M. Hicks Beach stated that the Board of Trade refused to proceed with the applications of the companies for electric lighting powers in Leeds in consequence of their not having obtained the consent of the local authority. The Corporation of Leeds, he said, state that a committee of their body are engaged in an exhaustive examination of the question of the supply of electricity, and they ask that the matter may be postponed until next year. The Board of Trade, in these circumstances, declined to dispense with the consent of the Corporation; but informed that body that, in the event of their not being prepared to apply for powers themselves next year, the department would have to consider whether they could refuse to grant powers to other promoters.—In the House of Commons on Tuesday night Sir M. H. Beach stated, in answer to Sir J. Pease, that the mere fact that certain members of local authorities were shareholders in gas companies within the districts of the local authorities would not of itself be deemed a sufficient reason to justify the Board of Trade in dispensing with the consent of such local authorities to Provisional Orders applied for by private promoters. If, however, it could be shown that the refusal of a local authority to give their consent was due to the votes of any members who were improperly influenced in giving these votes by their personal interest in local gas undertakings, he would be disposed to consider the expediency of directing an inquiry into an application to dispense with that consent.

The International Telegraph Congress.—Out of the 150 invitations to take part in the Congress at Paris, 90 have been accepted; 37 Government Administrations and 53 telegraph companies are included in the latter number. The festivities in honour of the Congress will be a banquet, an evening at the opera, and two official receptions and entertainments at Compiègne and Versailles. The British Post Office will be represented at the Congress by Mr. J. C. Lamb, Mr. H. C. Fischer, and Mr. P. Benton. These gentlemen will also represent the Cape Colony and Natal. The Australasian Colonies will be represented by their Agents-General as follows:—Victoria, Sir Graham Berry, K.C.M.G.; South Australia, Sir Arthur Blyth, K.C.M.G., C.B.; New Zealand, Sir Francis Dillon Bell, K.C.M.G., C.B.; Tasmania, Mr. E. N. C. Braddon.—The Telegraph Companies will be represented as follows:—African Direct, Sir John Pender, K.C.M.G., Most Hon. Marquis of Tweeddale, Mr. T. Fuller; Anglo-American, Mr. Henry Weaver, M. Jules Despecher; Black Sea, Sir John Pender, K.C.M.G., Sir James Anderson, Mr. Lewis Wells, M. Jules Despecher, Mr. W. Hibberdine; Brazilian Submarine, Mr. Thomas Fuller; Direct Spanish, Mr. Charles Gerhardi, Senor A. Aparicio; Direct United States, Sir John Pender, K.C.M.G., Mr. W. Ford; Eastern, Sir John Pender, K.C.M.G., Sir James Anderson, Sir Albert Cappel, K.C.I.E., Mr. Lewis Wells, M. Jules Despecher, Mr. W. Hibberdine; Eastern Extension, Australasia and China, Sir John Pender, K.C.M.G., Mr. Lewis Wells, M. Jules Despecher, Mr. F. E. Hesse, Mr. W. Hibberdine; Eastern and South African, Sir John Pender, K.C.M.G., Sir James Anderson, Mr. Lewis Wells, M. Jules Despecher, Mr. W. Hibberdine; Great Northern, Captain Suenson, Captain Hedemann, Mr. F. C. C. Nielsen; Indo-European, Mr. W. Andrews, Mr. F. Moll; Spanish National Submarine, Mr. Robert Gray, M. F. de P. Vazquez, Mr. W. F. O'Brien; West India and Panama, Mr. W. S. Andrews, Mr. H. Weaver; Western and Brazilian, Mr. W. S. Andrews, Major Wood, Mr. R. M. Cunningham; West African, Sir John Pender, K.C.M.G., Sir James Anderson, Mr. W. Payton, Mr. Lewis Wells, and Mr. W. Hibberdine.

Digitized by Google

MAGNETISM IN IRON AND OTHER METALS.*—XVI.

BY PROF. J. A. EWING, F.R.S.

(*Continued from page 616.*)

§ 69. **Cast Iron.**—Cast iron reaches a somewhat lower magnetisation than wrought iron or steel, even under strong forces. The intensity, when saturated, is about three-quarters that of wrought iron. In permeability, under moderate magnetising forces, and in coercive force, it generally resembles mild steel. Fig. 37 (from Hopkinson) exhibits half of a cyclic of magnetisation, for what is probably an exceptionally soft specimen of grey and cast iron, in which **the coercive force is barely double that of annealed wrought iron.**

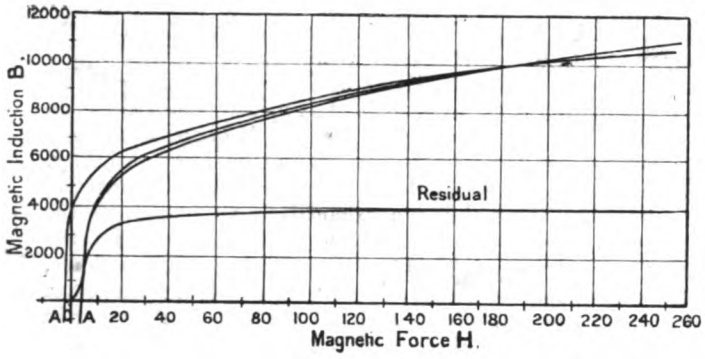


FIG. 37.—Cast iron.

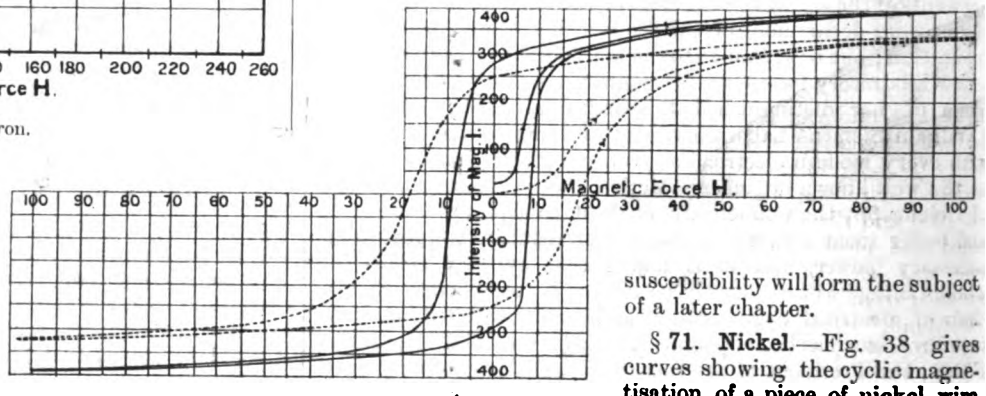


FIG. 38.—Nickel wire.

Annealed _____ Hardened by stretching .....

§ 70. **Non-Magnetic Steels.**—In certain alloys of iron there is a remarkable absence of magnetic quality. The presence of manganese in large quantities deprives the metal of nearly all its magnetic susceptibility. A notable instance occurs in the "manganese steel" of Mr. Hadfield, which contains about 12 per cent. of manganese and 1 per cent. of carbon. The permeability of this alloy is only about 1·3 or 1·5, and is sensibly constant in strong and weak magnetic fields. There is sensibly no residual magnetism, even after a very powerful magnetising force has been applied. A still more curious case is that of "nickel steel." Hopkinson* has found a specimen containing 25 per cent. of nickel to be practically non-magnetic under ordinary conditions of temperature, its permeability being constant and equal to about 1·4. Here we have two materials, nickel and iron, each strongly magnetic, becoming non-magnetic when combined. What makes this alloy peculiarly interesting is the further fact that when cooled to a very low temperature, it becomes strongly magnetic, and remains so after the temperature is again allowed to rise to ordinary atmospheric values. The effects of temperature on magnetic susceptibility will form the subject of a later chapter.

§ 71. **Nickel.**—Fig. 38 gives curves showing the cyclic magnetisation of a piece of nickel wire (0·068 cm. india meter, and 25·4 cms. long) first in the annealed state (full lines) and next after being hardened by stretching beyond the limit of elasticity (dotted lines).† The curves give I, not B. They show that under strong forces the magnetisation

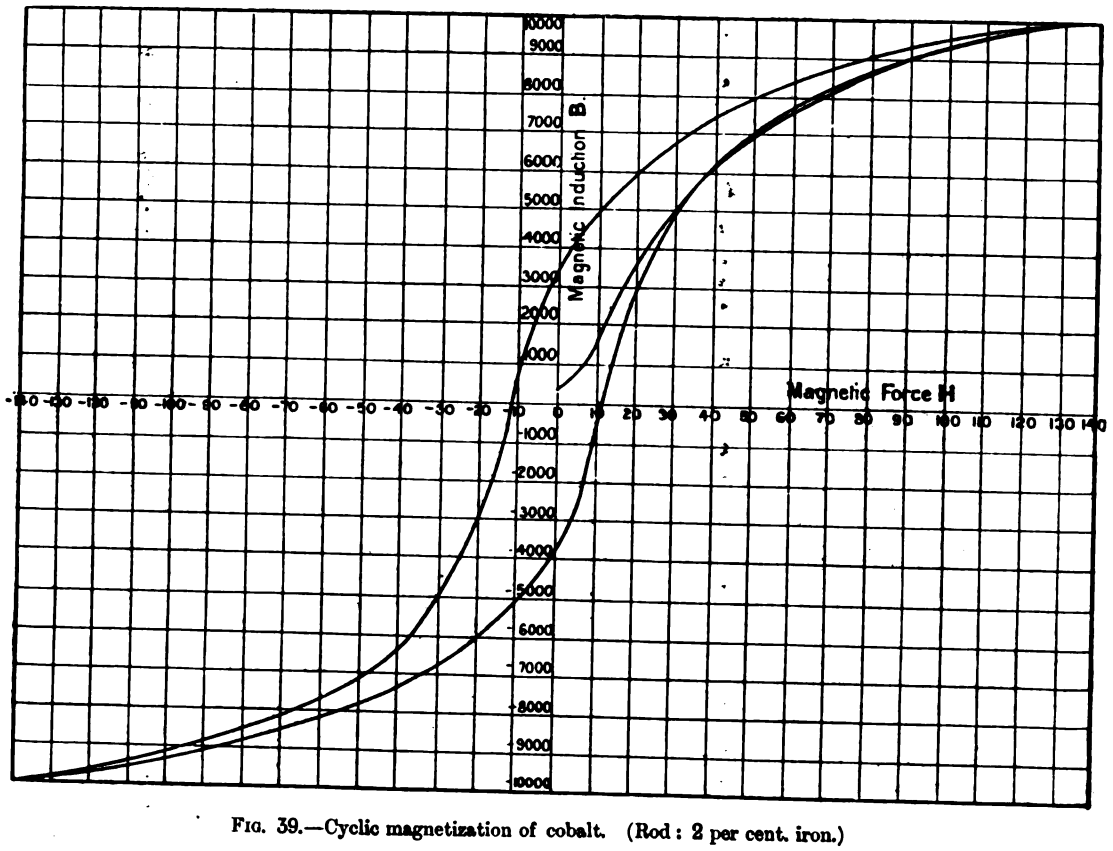


FIG. 39.—Cyclic magnetization of cobalt. (Rod: 2 per cent. iron.)

* All rights are reserved.

* *Proc.* Roy. Soc., Dec. 2, 1889. † *Phil. Trans.*, Vol. 179A, 1888, p. 327.

Digitized by Google

reached by nickel is greatly inferior to that reached by wrought or cast iron or ordinary steels. (The saturation value of I in nickel is $\frac{1}{3}$ or $\frac{1}{4}$ the saturation value in wrought iron.) The following numbers refer to the experiment of Fig. 38 when the wire was in the soft state :—

Annealed Nickel Wire.

H	I	κ
0	22	
4·0	36	
6·5	83	12·8
8·0	177	22·1
9·5	223	23·5
10·9	251	23·0
12·3	273	22·2
24·6	325	13·2
52·6	371	7·1
79·7	392	4·9
103·4	401	4·0
0	284	
-7·5	0	

The last numbers in columns 1 and 2 of the table show the residual magnetism and coercive force. The greatest susceptibility ($\kappa = 23·5$) corresponds to $\mu = 283$. In the test with hardened wire the maximum susceptibility κ was only 8·3 ($\mu = 105$) and the coercive force was 18. The curves for annealed and mechanically hardened nickel differ in much the same way as the corresponding curves for annealed and hardened iron.

Rowland,* using a ring of cast nickel, found a maximum susceptibility of 17 6 (permeability 222), and reached a value I equal to 434 with a force H of 104.

§ 72. **Cobalt.**—Cobalt has decidedly more capacity for magnetisation than nickel. Under the action of a strong field it takes up about as much magnetism as cast iron ; it has, however, comparatively little susceptibility when the magnetising force is weak.

Fig. 39 exhibits an experiment on the cyclic magnetisation of a cobalt rod (containing about 2 per cent. of iron), cast and turned, and tested, within a yoke, in the manner described in § 58, the magnetism at each stage being determined by summing the ballistic effect of successive steps. There was a small amount of initial magnetism, not removed when the experiment began. The greatest permeability occurs when the force is about 25, and its value is 174, which corresponds to a susceptibility of 13·8. Rowland, using a cast cobalt ring, found a maximum susceptibility of 11·2.

The curves for cobalt have a rounded outline recalling those for hardened iron. One effect of this is that the residual magnetism is comparatively small. The coercive force in Fig. 39 is 12.

(To be continued.)

THE CLARK STANDARD CELL.

BY PROF. H. S. CARHART.

My attention has only quite recently been called to Lord Rayleigh's remarks on the above subject in *The Electrician*, January 24, 1890, p. 285, referring to my Paper in the *Philosophical Magazine* for November, 1889.

Lord Rayleigh, who has made such important contributions to our knowledge of the conditions requisite for a good standard cell, says that "the lower temperature coefficient would be an advantage in itself, if it could be obtained without loss in other respects." This advantage I think I have secured, not only without loss in other respects, but with certain additional advantages. The low coefficient of ·00039 is not due to the separation of the zinc from the mercurous salt, but is obtained by standardising the zinc sulphate solution. My solution is saturated throughout, not at the temperature recommended by Lord Rayleigh, but at zero C. I adopted this method because an increase in the density of the zinc sulphates operates to lower the E.M.F. If, therefore, the sulphate solution is saturated at say 30° C., when the temperature falls the excess crystallises out, and the E.M.F. rises for two reasons, one due directly to the change in temperature, the other to a diminution in the density of solution. When the temperature rises the zinc sulphate again goes into solution, with the result of affecting the E.M.F., and of making the solution of unequal density at different levels. This inequality continues till rectified by diffusion ; and if the change in temperature is not very slow, it may perish for a long period. Hence the temperature coefficient of such a cell, determined by means of somewhat rapid variation of temperature, will be lower than when it is derived from a series of observations extending over a long period. This is clearly brought out in Prof. Threlfall's Paper in the *Philosophical Magazine* for November, 1889. For rapid temperature change he obtained a coefficient of ·00040 in the case of a cell made up in accordance with Lord Rayleigh's directions.

On account of this inequality of density where undissolved crystals of zinc sulphate are present, the zinc is sometimes eaten away at the surface of the liquid, where the density is least, and is deposited again on the zinc rod at the surface of the mercurous salt, where the liquid in contact with zinc sulphate crystals is saturated. This is probably due to the difference of the E.M.F. between the zinc and the solution at different densities. These disadvantages are avoided by saturating the solution at a temperature lower than that at which the cell is to be used. The change in E.M.F. with temperature is then reduced to a purely thermal one. In order to use this method the greatest care must be employed in making the mercurous sulphate, so that it can be washed entirely free of acid without turning yellow. The paste must be poured into the tube as soon as it is mixed, to prevent evaporation. I do not use any zinc carbonate, and my cells now show too high an E.M.F. when first set up, in consequence of any acid in the salt. It was an inadvertence on my part not to notice that Lord Rayleigh's sample of mercurous sulphate turned yellow only on rubbing up with *zinc carbonate*, together, of course, with zinc sulphate. Since reading Lord Rayleigh's article in *The Electrician* I have tested some of my mercurous sulphate with zinc sulphate and zinc carbonate together, and find that it remains quite free from any yellow colour ; so that I apparently have mercurous sulphate at least approximately free from admixture with the mercuric form.

The method which I have adopted requires efficient dealing to prevent evaporation. Cells subjected to considerable changes of temperature sometimes show a separation of the sealing compound from the glass, thus allowing the liquid of the cell to come out by capillary action. This appears to be due to a large difference in the coefficients of expansion of glass and the sealing material. I have recently adopted a new device to diminish this difference, but it is too soon to speak positively about it.

If the zinc dips into the mercurial salt zinc displaces mercury, thus increasing the density of the solution. It is on this account that I separate the zinc entirely from the solid mercurous sulphate. I have recently observed that M. Guoy does the same thing with his mercury oxide cells. Since a standard cell is not supposed to do any work, the density should remain constant when the conditions are such as to prevent local action.

The Protection of Iron from Rust.—Herr Haswell, of Vienna, proposes to protect iron from rust by coating it with a layer of electrolytically deposited manganese dioxide. The iron is made the anode of an electrolytic bath, containing a ·05 to ·5 per cent. solution of chloride or sulphate of manganese, and from 5 to 20 per cent. of ammonium nitrate. Carbon is used for the cathode. On passing the current the iron becomes coated with a firmly adherent and inoxidisable film of manganese dioxide.

* *Phil. Mag.*, November 13, 1874.

Digitized by Google

THE LODGE LIGHTNING GUARD.

As we are unable to publish Dr. Lodge's Paper in the present issue, owing to the fact that it was delivered only from notes, a brief description of the instrument itself may prove of interest to those of our readers who were not present at the meeting last week.

The chief feature of Dr. Lodge's ingenious and beautifully-simple device for protecting cables and electrical apparatus from injury by lightning and high-tension discharges in general consists in placing a *number* of air gaps, or their equivalent, between the line and the apparatus to be protected. This principle, of course, admits of a variety of practical solutions, and in Fig. 1 we have a diagramatic representation of one of the methods proposed by Dr. Lodge. L and E are terminals, connected respectively with the line and with earth, T_1T_2 are

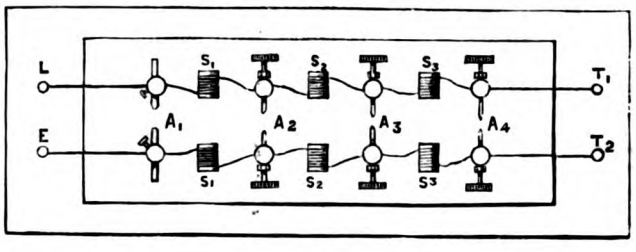


Fig. 1.

terminals in connection with the instrument to be protected. A_1, A_2, A_3, A_4 are air gaps, and S_1S_1, S_2S_2, S_3S_3 are impedance coils. The air gaps, it will be observed, decrease in width, and the wire composing the coils becomes gradually finer. The broad effect of this particular arrangement, which we hasten to add is not greatly insisted on by its author, is to

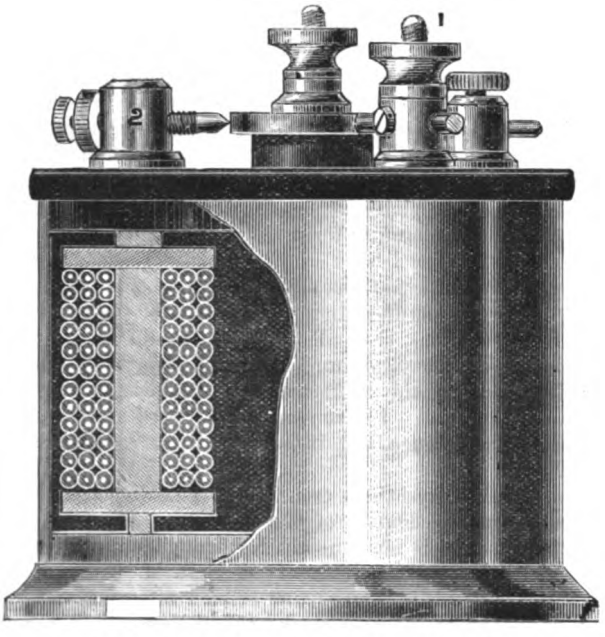


Fig 2.—The Lodge Lightning Guard (circular pattern).

present an increasingly difficult path to the discharge in the direction of the instrument which it is required to protect, and an increasingly easy path to earth. The coils may be composed of the same wire throughout, the air gaps may be of the same width and the terminals may be connected up in a variety of ways. A lightning-conductor of this form, it is obvious, offers great self-induction on the one hand, and dielectric weakness on the other, to the lightning, and air-resistance obstruction on the one hand, and thick wire conduction on the other, to the useful current. The superiority of this device over ordinary single air-gap protectors, at any rate in the case of powerful discharges from a large Wimshurst machine, is most marked. It is unnecessary to add that the self-induction of the coils is inappreciable for ordinary currents, and that they contain no iron cores. In Fig. 2 we have a perspective view and in Fig. 3 a diagram of the connections of an actual protector of the circular pattern, as constructed by Dr. Alexander Muirhead. The central boss is connected to the brass case by means of a rod down the centre. Underneath, in the base of the instrument, is a screw to which a direct connection with the earth is made. The screw on the central boss at the top

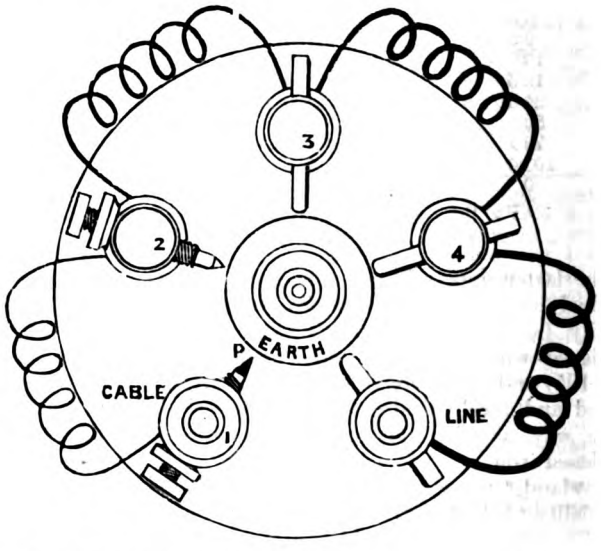


Fig. 3.—The Lodge Lightning Guard (circular pattern). Diagram of connections.

is only used when a handy earth is wanted for an instrument. The first projecting rod is of platinum, the second of brass, and the remaining three are of copper. This arrangement, it will be seen, is equivalent to that shown in Fig. 1, with the lower row of coils omitted.

THE PHYSICAL SOCIETY.

At the meeting of this Society, held on the 18th April, Prof. A. W. Rücker, F.R.S., communicated some of the results most recently obtained in the Magnetic Survey upon which he has been engaged in conjunction with Prof. Thorpe for some time past.

The Professor observed that in the account of their work already published they had pointed out that the tracts of country surveyed could be divided up into distinct districts; and the distribution of the magnetic force in these districts had led them to form the provisional hypothesis that the variations were mainly due to the presence of large masses of magnetic rocks. If the hypothesis were correct it was to be expected that the vertical magnetic force would be a maximum over the central portions of such a mass, and that the horizontal forces would be deflected towards the centre. This had only been absolutely proved to be the case in two instances, though in other instances it appeared highly probable.

In order to investigate the matter further they selected two test districts for more minute examination last summer. The districts selected were the west coast of Scotland, and Lincolnshire and Yorkshire. These were selected because, in the first place, the local variations in these districts were very considerable, owing, probably, to the large masses of basalt present in them, and in the second place because they lay near the boundaries of the survey, so that any errors in the calculation of the normal force would be most likely to show themselves there. Magnetic maps of these districts, plotted from the observations made last summer, were then exhibited.

The map of the Lincolnshire and Yorkshire district exhibited a magnetic ridge line, coinciding with the line of the Wolds, and along this ridge line the local variation in the vertical force was a maximum, while the horizontal forces were deflected towards it at points on either side of it. The map of the West Coast of Scotland showed

Digitized by Google

that the distribution of the magnetic force was of the character which would be expected to follow from the presence of a large submerged mass of magnetic rocks off the south-west coast, due south of the Hebrides. The authors had calculated what the forces ought to be according to some observations made by Welsh in 1859 and 1860, and they found that they led to the same conclusions as their own.

In conclusion, Prof. Rücker stated that an application was being made to the Royal Society to assist in carrying out further observations.

DISCUSSION.

Mr. WHIPPLE complimented Professors Rücker and Thorpe on the great advances made by them in the carrying out of Magnetic Surveys. General Sabine, in his Magnetic Surveys, had only paid attention to the direction of the magnetic force, without considering its amount; and the early death of Welsh, who had first called attention to the large deviations in the Hebrides and other parts of Scotland, put a stop to the work on which he was engaged in 1859 and 1860. He did not think it likely that Welsh had any idea of the interesting relation between the magnetic deviation and the local geological formation pointed out by Professors Rücker and Thorpe. Sabine's attention had been almost exclusively devoted to the horizontal force, and the same was the case with the Admiralty observations until quite recently. The map of the lines of magnetic force constructed by the late Sir F. Evans was founded only upon the rough observations made by sailors to determine the variation of the compass. The older surveys were all made by simply counting, by the aid of an ordinary watch, the oscillations of a short magnet, which was merely compared before and after the voyage with a standard permanent magnet kept at Woolwich; and this standard magnet was assumed to remain constant, its intensity of magnetisation being assumed as unity. No temperature corrections were made in these surveys. The small effects observed by Professors Rücker and Thorpe were, therefore, completely masked.

Professor CAREY-FOSTER expressed his admiration of the manner in which the survey had been carried out, and considered that the observations were likely to lead to results of great interest and importance.

The SECRETARY then read a translation of a Paper, which had been communicated in French by M. Osmond, on

"A Theory of Permanent Magnetism."

The author pointed out that iron exists in at least two molecular states—soft iron, annealed and slowly cooled, which he has called α-iron; and this, when raised to a certain critical temperature, passes into the second form, which he has called β-iron, and the latter state is partly retained on cooling, especially if the cooling is rapid and the iron contains a considerable proportion of carbon and manganese. Electrolytically-deposited iron is of the β variety, which may also be produced by cold hammering. The author then regards a bar of steel, after allowing for the carbides, phosphides, and sulphides which may be mixed with it, as consisting of an intimate mixture of the two varieties in proportions which are determinate at any one point, but may vary from point to point. He supposes the β-iron to form a sort of porous non-magnetisable framework, interlaced with polarisable and mobile particles of α-iron. These particles after displacement, caused by placing the mass in a magnetic field, will be prevented from returning completely to their original positions by the presence of the rigid framework of β-iron, and so a permanent magnet will be formed.

The Paper was accompanied by a diagram in which the author attempted to depict his theory graphically. He thought it explained the fact that expansion, shocks, or vibration tend to diminish the permanent magnetism of a bar, as any of those would tend to make the framework more open, and, therefore, allow the polarisable particles to move more freely. The magnetising force required to produce saturation would increase with the proportion of β-iron, which was in agreement with the experimental fact that iron containing a large proportion of carbon or of manganese—Speigel iron, for example, which contains 25 per cent. of manganese—is non-magnetic. The theory also explains the difficulty, after a bar has been magnetised to saturation, of magnetising it to the same extent in the opposite direction; this being due, on the author's theory, to some of the particles of the α-iron being immovably entangled within the framework of β-iron.

DISCUSSION.

Prof. AYRTON observed that the author's theory would not afford any explanation of the enormous effect of the presence of a small proportion of tungsten in the iron.

Mr. SWINBURNE stated that some experiments which had recently been made showed that the permeability in a given direction is different after magnetisation in a direction at right angles to this, from its value previous to such magnetisation; and the author's theory, or theories of a similar character, would not suggest any explanation.

BOOKS, &c., RECEIVED.

"Gas and Petroleum Engines." A Practical Treatise on the Internal Combustion Engine. By William Robinson, M.E. (London: E. and F. N. Spon.)

"Chronological, Historical, and Heraldic Charts of the Royal House of England, from King Egbert to the Present Time." By I. A. Timmis, M.Inst.C.E. (London: Henry Sotheran and Co.)

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To night) FRIDAY, May 2nd.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "Théophile Gautier." By WALTER H. POLLOCK, M.A.

PHYSICAL SOCIETY.

5 p.m. Papers to be read: "The Distribution of Flow in a Strained Elastic Fluid." By C. A. CARUS-WILSON. "Photographs of Rapidly Moving Objects," and "The Oscillating Electric Spark." By Prof. C. V. BOYS.

SATURDAY, May 3rd.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture: "Colour and its Chemical Action." By Captain W. DE W. ABNEY, R.E., F.R.S.

MONDAY, May 5th.

ROYAL INSTITUTION.

5 p.m. General Monthly Meeting.

SOCIETY OF ENGINEERS.

7.30 p.m. Ordinary Meeting. Paper to be read: "Breakwater Constructions." By F. H. CHEESEWRIGHT, M.Inst.C.E.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture: "Sugar, Tea, Coffee, and Cocoa, their Origin, Preparation, and Uses." By RICHARD BANNISTER.

TUESDAY, May 6th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture: "The Art of Engraving." By LOUIS FAGAN.

INSTITUTE OF MARINE ENGINEERS.

7:30 p.m. Paper to be read on "Electricity." By J. MCFARLANE GRAY.

ROYAL VICTORIA HALL.

7:30 p.m. Science Lecture: "Birth and Death of Mountains." By W. W. WATTS.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be read: "The Screw-Propeller." By M. SYD. W. BARNABY, M.Inst.C.E.

WEDNESDAY, May 7th.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. "The Aim and Scope of Higher Technical Teaching." By Dr. PERCY F. FRANKLAND.

THURSDAY, May 8th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture: "Flame and Explosives." By Prof. DEWAR, F.R.S.

SOCIETY OF ARTS.

5 p.m. Indian Section: "The Western Frontier of China." By DEMETRIUS BOULGER.

8 p.m. Lecture: "Design Applied to Wood Carving." By LEWIS F. DAY.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Discussion on the following Paper: "On a Lightning Guard for Telegraph Purposes, and on the Protection of Cables from Lightning." By Dr. OLIVER LODGE, F.R.S. Paper to be read: "The Treatment, Regulation, and Control of Electric Light by the Legislature and the Board of Trade." By Major P. CARDEW, R.E.

CHEMICAL SOCIETY.

8 p.m. Extra Meeting. Exhibition of Apparatus, &c.

FRIDAY, May 9th.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "Colour Vision and Colour Blindness." By R. BRUDENELL CARTER, F.R.C.S.

SATURDAY, May 10th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture: "Recent Excavations in Greece." By CHARLES WALDSTEIN, Ph.D.

***** Particulars of meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.**

Digitized by Google

The Electrician.

Published every Friday. Price Fourpence; Post Free, Fourpence Halfpenny.
Editorial, Publishing and Printing Offices:

SALISBURY COURT, FLEET ST., LONDON, E.C.

Telephone No. 2714. *Telegrams:* "ELECTRICIAN NEWSPAPER, LONDON."

All Communications to be addressed to "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN."

All letters intended for insertion in "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. Subscribers should receive their copies by the first post on Friday morning.*

"THE ELECTRICIAN" *is on sale at the railway bookstalls throughout the United Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices as above.*

SPECIAL NOTICE.

Owing to the increase in the number of pages of "THE ELECTRICIAN," in order to partly cover the increased postage, we have been compelled to revise the rates for Foreign Subscriptions, which are now as follows:—

	3 months.			6 months.			12 months	
For Foreign Parts and Colonies:—	s.	d.		s.	d.		s.	d.
Within Postal Union	6	6	...	12	6	...	24	0
Aden, Borneo, Ceylon, China, India, Japan, Java Labuan Mozambique, New Caledonia, Persia, Philippine Islands, Siam, Transvaal, and Zanzibar	7	6	...	14	6	...	28	0
The rates for the United Kingdom remain as follows:—	5	0	...	10	0	...	19	6

TO ADVERTISERS.

"THE ELECTRICIAN" *offers exceptional advantages to Advertisers.* **It has the largest circulation of any English Electrical paper, and circulates all over the World.**

Particulars relating to Advertisements will be promptly forwarded on application to the office.

TRADE ADVERTISEMENTS *intended for the current issue must be handed in not later than First Post on Thursday morning.*

SMALL PREPAID ADVERTISEMENTS *(for Rates see page xv.) are accepted up to 4:30 p.m. on Thursday.*

TECHNICAL PRINTING.

"THE ELECTRICIAN" PRINTING AND PUBLISHING COMPANY (LIMITED) *beg to inform Electricians, Electric Light Engineers, &c., that they make a specialty of Technical Printing, and have a Staff thoroughly acquainted with Electro-Technology. They can, therefore, promise Accuracy and Despatch in the Printing of Electrical Catalogues and Electro-Technical Literature generally.*

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.

Royal 8vo, 5s., postage extra.

Early in each year is issued "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK. *The* DIRECTORY *was established in 1883, and the 1889 Edition consisted of more than 600 pages of printed matter. The names and addresses of all persons engaged in the Electrical Industries may be relied upon as accurate. Useful Tables and Electrical Formulæ, and information specially compiled for this work are given, together with popularly-written Biographical Notices of the leading Electricians, Electrical Engineers, &c., accompanied in many cases by Portraits.*

The issue for 1890, which is still further enlarged and improved (making 850 pages), is NOW READY. Orders should be forwarded at once to the Publishing Offices, Salisbury-court, Fleet-street, London, E.C.

CONTENTS OF THE CURRENT NUMBER.

NOTES 637
Magnetism in Iron and other Metals.—XVI. By Prof. J. A. Ewing, F.R.S. Illustrated. Continued 642
The Clark Standard Cell. By Prof. H. S. Carhart 643
The Lodge Lightning Guard. Illustrated 644
Physical Society—Meeting 644
"A Theory of Permanent Magnetism" 645
Books Received 645
Meetings of Scientific Societies. 645
THE EDINBURGH EXHIBITION ... 646
Ayrton and Perry's Twisted Strip Voltmeter. Illustrated 647
The Benest Submarine Cable Grapnel. Illustrated 649
On the Effect of Tension upon Magnetic Changes of Length in Wires of Iron, Nickel, and Cobalt. By Shelford Bidwell, M.A., F.R.S. 649
The Central London Railway Bill 651
The Railway Rates Inquiry ... 652
Electric Lighting at Brighton. Local Government Inquiry... 653
CORRESPONDENCE—
Lightning in Electric Light Leads.—Oliver J. Lodge... 654
Electric Welding—F. Higgins 655
CORRESPONDENCE—*Continued.*
The Diathermancy of Air in Relation to the Efficiency of Incandescent Lamps.—C. J. Robertson 655
PATENT RECORD 655
COMPANIES' MEETINGS, &c.—
The Indo-European Telegraph Company (Limited)..... 656
Great Northern Telegraph Company of Copenhagen... 657
The Telephone Company of Ireland (Limited)..... 657
The Oriental Telephone Company (Limited)..... 658
China and Japan Telephone Company (Limited) 658
The Brighton and Hove Electric Light Co. (Ltd.)... 659
Brazilian Submarine Telegraph Company (Limited). 659
The West India and Panama Telegraph Company (Ltd.) 659
The Western and Brazilian Telegraph Company (Ltd.) 659
The Anglo-Portuguese Telephone Company (Limited) 660
House-to-House Electric Light Supply Company (Limited) 660
Submarine Cables Trust..... 661
New Companies Registered ... 661
City Notes, &c..... 661
Companies' Share List 662

SPECIAL NOTICE.

The present number of "THE ELECTRICIAN" completes Volume XXIV. With next week's number will be issued the Index to the Volume.

READY NEXT WEEK.

Volume XXIV. of "THE ELECTRICIAN," price 12/6, post free, 13/6.

NOW READY.

Cases for binding Volume XXIV., price 2/0, post free, 2/3.

"THE ELECTRICAL WORLD" OF NEW YORK.

"THE ELECTRICAL WORLD" OF NEW YORK *can be obtained from* "THE ELECTRICIAN" *Office, Salisbury-court, Fleet-street, London, E.C. The Rate of Subscription (payable in advance), is* **£1 1s.** *per annum. Single Copies* **price 6d. each; post free, 8d.**

THE EDINBURGH EXHIBITION.

The International Exhibition which was formally opened at Edinburgh yesterday is the happy outcome of what was at first a not very promising project. Judging by present appearances, its career during the ensuing season will be as prosperous as such undertakings usually are, and possibly even more so. For the Edinburgh Exhibition starts with many local advantages which some of its predecessors have not enjoyed, and with a management the enterprise and activity of which leave nothing to be desired. This is the more gratifying because of the inauspicious circumstances under which the idea was started. At first it was intended as an Electrical Exhibition only, or at all events chiefly; and certainly no part of the United Kingdom could show a better reason than Scotland for such a mode of advancing an industry in which that country, with its abundance of water-power and other natural resources, is so well fitted to take the lead. It was argued also that so rapid was the progress of electrical inventions that,

Digitized by Google

although following close on the heels of the Paris Exhibition, there was ample room for another in the northern British capital. These arguments, however, did not suffice to win adherents from over the border; and at one time it seemed likely that English electrical firms would decline to take part in the venture. It soon became evident to the promoters, therefore, that the local conception would have to be abandoned, and an International one taken up in its stead. With this alteration of programme there followed necessarily a great modification in respect to the electrical character of the Exhibition; and although electrical exhibits have preference over others in respect to space and position, as a whole the attraction for the general public will not differ materially from those of International Exhibitions generally where the special objects are less pronounced.

This change of plan is by no means to be regretted. A special Electrical Exhibition, it is true, is not much needed just now; but since electricity in some shape or another is bound in these days to form an important feature of any large Exhibition, it would not benefit the electrical industry to be associated with an enterprise which, for want of ordinary business foresight, might be a financial failure. In plain words, it is better to be part of a successful show than to be the whole of an unsuccessful one. And as a matter of fact the industrial applications of electricity, although daily increasing in number and importance, are beginning to lose some of the interest which they aroused in the public mind in the early pioneering days of the science. We are glad, therefore, to notice that the Edinburgh International Exhibition possesses apparently other elements of popularity. It has the advantage of a picturesque situation near to one of the most interesting historic cities of the world. Railways and tramlines run close by its doors; and the grounds which surround it are not only beautifully laid out, but amply provided with outdoor recreations for the people. Inside there is a spacious concert hall and various other places of entertainment; while the collections of sculpture and art treasures will satisfy the tastes of the more refined pleasure seeker. The building itself, although of considerable dimensions, having proved too small for the space demanded, additional annexes have been provided far in excess of what was contemplated; and the exhibits are of that miscellaneous description which commands the attention of ordinary sightseers. When it is added that the exhibition is opened under Royal patronage and will probably be visited by the Queen in person, its prospects seem to be exceptionally good.

We have mentioned that the space allotted in the first instance had to be greatly enlarged, chiefly to meet the demands from Italy, France, Belgium, Germany, and the British Colonies; but, even then the right of rejection or curtailment has had to be exercised very freely. As regards electrical exhibits, however, the promoters have adhered to their original design so far as to accept all applications that have been received; and the result has been very satisfactory. We hope to give some account of the more important electrical exhibits in due course; and, for the present, we confine ourselves to the remark that the hall set apart for electrical and other machinery is 680 feet long and 150 feet broad, and is already fairly well filled up. The building is lighted by electricity, as a matter of course, and sufficient steam-power is provided on the spot to run the dynamos for purposes of exhibition or testing. Outside there is an electrical railroad, and a telpher line; and on the neighbouring canal there are to be four electric launches, by means of which passengers will be conveyed—or shall we say moteled?—to and from the Exhibition grounds. Thanks to the exertions of the Electrical Trades' Section of the London Chamber of Commerce, advantageous terms were made with the promoters at Edinburgh, both as regards the insurance and the charges for space. As to the latter, it was agreed that the electrical trades should deposit the fees common to all exhibitors, but that in proportion to the profits of the Exhibition those fees shall be remitted when the affairs are wound up. The electrical industry will thus have a direct interest in the prosperity of the Exhibition; and it is to be hoped that this experiment in profit-sharing, so to speak, will establish an encouraging precedent for future use. One other point on which the Electrical Trades Section was particularly anxious to obtain some clear understanding has not yet been satisfactorily settled. We refer to the question of tests and awards. Alternating-current machinery and transformers were particularly referred to as standing in great need of some reliable tests at the present moment; the difficulty was to agree upon the jury who should do the testing. It may be hoped that this obstacle will be overcome before the Exhibition closes, and that such a capital opportunity will not be allowed to slip owing to the jealousies of exhibitors or the backwardness of competent and impartial examiners.

AYRTON AND PERRY'S TWISTED STRIP VOLTMETER.*

At the Physical Society some years ago, I announced that a strip of material to which a permanent twist had been given behaved in much the same way as one of our now well-known springs; that is, when it was elongated by axial forces there was a relative rotation of the ends; in fact, the twist gets less. As some people have a difficulty in understanding what I mean by a twisted strip, I have prepared Fig. 1 to illustrate my meaning.

Fig. 1.

The relative rotation is perhaps better seen in a strip whose permanent twist is right-handed at one end and left-handed at the other. If a point be attached to the middle, as shown at A Q B, Fig. 2 or Fig. 3, and the ends are pulled out, the pointer rotates. This double-twisted strip we have applied to weighing machines, aneroid barometers, and many other instruments, such as wire-testing machines; and I can recommend its use in all cases where a force has to be measured, and where it is not advisable that there should be a considerable amount of yielding. For example, spring balances are sometimes used acting directly on specimens as testing machines; but when the specimen breaks, the recoil of the balance is likely to cause it to get out of order. Again, if a double twisted strip is used as a tension piece in a jointed structure, a pointer set at its middle will indicate the pull at any time.

The only likely suppositions I could make in thinking of what occurs in a twisted strip were, first, that two spiral filaments symmetrically disposed relatively to the axis resembled the two threads in a bifilar suspension, if a sufficiently short length of strip was considered; second, that the tensile stress was uniform over a cross section of the strip at right angles to the axis; third, that the resisting couple was due to the torsional rigidity of the section of the strip still taken as rectangular.

These suppositions lead to the result that

$$\phi \propto \frac{w l n b}{t^3},$$

* A Paper read by Prof. Perry at the British Association Meeting at Newcastle, 1889.

Digitized by Google

when w is the axial force, l the length of the strip, n the number of complete spires given by permanent set to unit length of the strip, b the breadth of the strip, and t its thickness, ϕ being the small rotation produced by the small load, w.

Now, such experiments as I have made hitherto on steel strips point rather to some such law as the following, being roughly correct,

$$\phi \propto \frac{w\,l}{b\,t^3};$$

that is, the rotation seems to be independent of the amount of twist originally in the strip, and instead of increasing as the breadth of the strip increases, it diminishes. It is evident that the action is a much more complicated one than I had imagined.

Now, I found that when a double-twisted strip was placed in tension and its ends were fixed, the pointer rotated if the temperature was altered, so that its use as a pyrometer or thermometer was possible.

In this instrument before you (Fig. 2) we have a tube A H D C B, about two-thirds of whose length, A H D, is brass and about one third, C B, is iron. A double-twisted strip of platinum-silver is in tension in the axis of the tube with its ends fastened to the ends of the tube, but one of them electrically insulated from the tube. The tube just at the middle of its length, D G, becomes a strong thin bracket, which enables a pointer, Q P, attached to the strip to make a rotation of nearly 360 degrees,

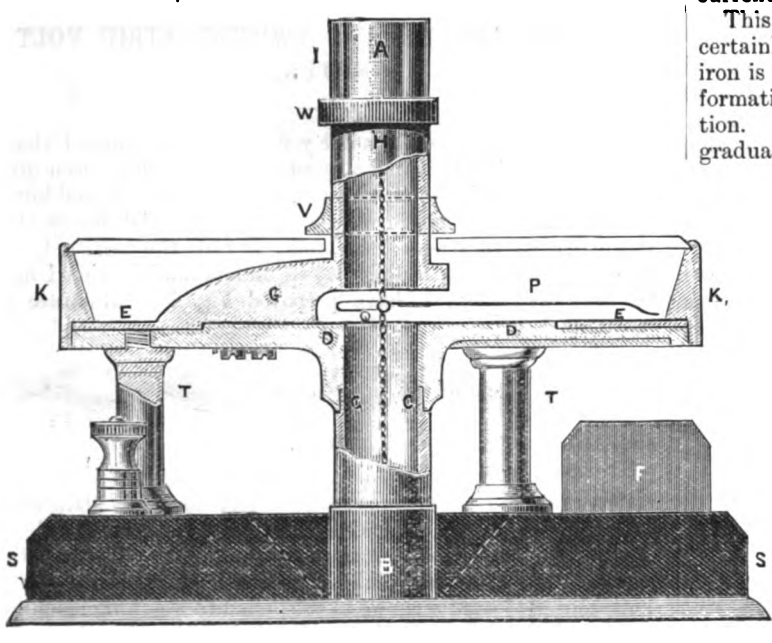


Fig. 2.

making the current once in every minute. This process is performed by the seconds hand of a clock passing into and out of a bath of mercury in every revolution. It is quite wonderful to observe the complete change in elasticity produced in a strip by this kind of fatigue. The strip seems to undergo no alteration afterwards by mere use or disuse; but it is my intention to test this by many months' experience before allowing these instruments to be manufactured. The two instruments before you are the only two yet made.

I had hoped to be able to show you one in which the strip is of flashed carbon. Here are specimens of twisted carbon strips, but unfortunately they are all too coarse for a 50-volt instrument, which is what I intended them for.

For accumulator work the 2½-volt instrument is greatly needed, and I prefer this form to our hot-wire instrument, because of its great simplicity and its needing so very little adjustment in manufacture.

For alternating currents this 2½-volt instrument may be used through any range whatever by placing a small transformer on the base of the instrument. The little transformer before you transforms in the proportion of 50 volts to 1, so that the instrument may be used on the ordinary 100 or 110 volt circuits. By using a different winding on the transformer the same instrument may be graduated for a 1,000-volt circuit. I find that this transformer maintains the same proportionate transformation of voltage whether the frequency of alternation of current is 50 or 100 per second.

This pleasing result was not altogether unexpected, but it certainly was unexpected to find that if a sufficient quantity of iron is used in the transformer there is a constant ratio of transformation of *current* for quite different frequencies of alternation. Hence, I find that this 2½-volt instrument may be graduated as an ammeter up to 1,000 amperes or more, or a

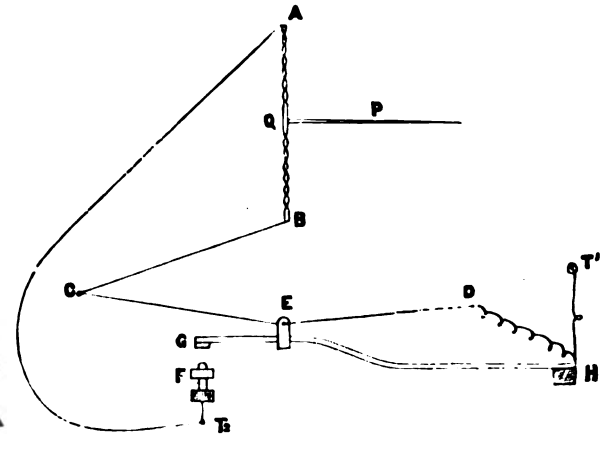


Fig. 3

and the arrangement of the bezel and dial will readily be understood without any further description. A and B are caps to the ends of the tube. When the cap A is turned, the initial pull in the strip is altered, and thus furnishes a zero adjustment.

When the various parts of this instrument are all at the same temperature the pointer remains in the same position whatever that temperature may be. When a current is passed through the strip, the pointer records the difference of temperature between the strip and its case, and hence the readings of the pointer on the dial may be made in amperes. Again, the readings may be in volts for the potential difference between the ends of the strip or the terminals of the instrument. These instruments before you read to 2½ volts. They waste almost exactly *one watt* at their highest reading.

By inserting resistances of platinoid, or of German silver, we can increase the range of the instrument, but, of course, we expend more energy in such a case.

That there may be no creeping, or sub-permanent set or hysteresis, we find it sufficient before graduation of the instrument to keep sending a current greater than the highest which is to be used on the instrument for 72 hours, breaking and

voltmeter to 1,000 volts or more, the transformer being the only variable thing about it. I need hardly say that with several transformers and resistance coils at the side of this instrument, we may almost call it a universal instrument.

Note.—The above Paper is given as it was written in September last. When it was written the author felt certain of the constancy of the fatigued strips. Six months of further experience have since confirmed his views.

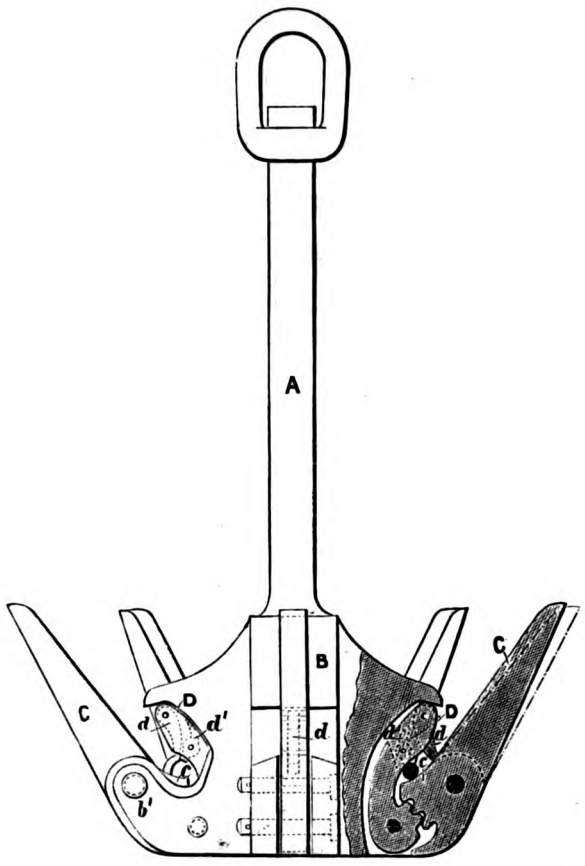
Added Later.—Fig. 3 shows our fuse arrangement.—T^1 and T^2 are the terminals of the instrument. Current flows from T^1 through the short thin copper wire T^1H, then through the adjustible resistance coil HD; then through the tightened platinum-silver wire DEC, whose ends are fixed, and which is kept sagged and tight by the metal spring HG; then through the twisted strip BA to the terminal T^2. But should the voltage between T^1 and T^2 be so great as to be liable to hurt the instrument, the wire DEC sags so much that the end G of the spring short-circuits the instrument through GH and the thin copper wire HT^1, the copper wire being instantly melted.

Digitized by Google

THE BENEST SUBMARINE CABLE GRAPNEL.

The object of this device, which is due to Mr. Henry Benest, of the Silvertown Works, is to provide a grapnel which will not merely hook a submerged cable, but will grip or hold the same fast when hooked. The essential feature of Mr. Benest's grapnel is the conversion of the flukes into automatically acting gripping jaws. The stem or shank of the grapnel is fitted with a boss which forms a guide for leading the hooked cable into the position to be gripped. Below this boss the shank is fitted with a thick plate carrying forked extensions standing out radially for the reception each of a fluke which is pivoted thereto. These flukes may be described as bell-crank levers, the short arms of which are intended to receive the pressure of the cable as it is caught, and thus cause the flukes which are in action to rise from their open position and close upon the cable, and grip it against the boss of the grapnel. By this arrangement it will be understood that the act of hauling in the grapnel will have a tendency to increase the grip of the grapnel upon the cable which it has caught.

The annexed figure shows in side elevation, partly in section,



The Benest Submarine Cable Grapnel. (Side elevation and section.)

one of these improved grapnels, fitted with a locking device. In this arrangement, instead of using the fixed gripping surfaces forming part of the boss B, a second movable jaw, D, is provided, which, like the fluke C, is pivoted within the sup porting arms extending horizontally from the boss. The jaws D are severally connected with their respective flukes C by interlocking teeth, which ensure the simultaneous approach of the jaws C and D to grip the cable when the pressure of the hooked cable comes upon the surface *c* of the tail of the flukes. Each jaw is slotted longitudinally to receive a locking pawl *d* and a tumbler d^1 situate below the pawl, and designed to move it into its locking position and retain it therein. These pieces, $d\,d^1$, are pivotally connected to the jaw D, and the end of the pawl, when in its locking position, enters a nick in the gripping face of the fluke C. The tumbler is so formed that, when not in action, its lower end will project somewhat from the gripping face of the jaw D, as shown on the left-hand side of the figure. This is for the purpose of enabling the cable, as it slides in between the gripping surfaces, to tip the tumbler d^1, and thereby bring into position the locking pawl *d*, as shown at the right-hand side of the figure. In order that the cable, whilst being hooked, may not be caught and lodge upon the top of the jaw-piece D, the cast boss is formed with a web which projects so as to cover the jaw-piece. The cable, it will thus be seen, being caught by the grapnel, and brought within the grip of the jaws C D, will be effectually prevented from escaping until released by hand after the recovered cable is suitably secured.

ON THE EFFECT OF TENSION UPON MAGNETIC CHANGES OF LENGTH IN WIRES OF IRON, NICKEL, AND COBALT.*

BY SHELFORD BIDWELL, M.A., F.R.S.

The *iron* used in these experiments was a piece of soft annealed wire, 0·7mm. in diameter and 10 cm. in length. The weights successively attached to it were equivalent to 1,950, 1,600, 1,170, 819, 585, and 361 kilos per square cm. of section. The *nickel* wire was 100mm. long, and 0·65mm. in diameter. The loads under which it was examined were 2,310, 1,890, 1,400, 980, 700, and 420 kilos. per sq. cm. The *cobalt* used was a narrow strip measuring 100mm. by 2·6mm. by 0·7mm.; its cross section being, therefore, 1·82 sq. mm. It was not possible to obtain this metal in the form of a wire. The loads employed for the strip were equivalent to 772, 344, and 75 kilos. per sq. cm. In all the experiments the loads were successively applied in decreasing order of magnitude, and before every single observation the wire or strip was demagnetised by reversals, without, of course, being removed from the coil.

The results obtained are shown in the curves in Figs. 1 to 4. Those in Fig. 3 are constructed from data obtained from Fig. 2; they show the magnetic contractions that would occur under increasing loads in constant magnetic fields of 125, 185, and 360 C.-G.-S. units respectively. These magnetic contractions would, of course, be superposed upon elongations of a purely mechanical nature, due to the tensional stress. In Fig. 4, for cobalt, the contractions corresponding to the various loads are indicated by different kinds of marks, and a single curve has been drawn as smoothly as possible through the whole of them. In all the figures magnetic fields (which are those due to the coil alone) are given in C.-G.-S. units, and increments and decrements of length are expressed in ten-millionths of the length (10 cm., or about 4 inches) of the experimental wire or strip.

Discussion of the Curves.

Iron.—The curves in Fig. 1 clearly show the effect of tension in diminishing the maximum elongation and hastening the contraction. With the two greatest loads used there was no preliminary elongation at all. The curve for an unstretched iron rod is generally found to cut the axis at about 300; probably, therefore, if the wire used in these experiments could have been tested with no load, its curve would lie a little above that for the load of 351 kilos.

Nickel.—The results for nickel are of great interest. In fields below about 140 units increase of load is always accompanied by decrease of magnetic contraction, the earlier portions of the six curves in Fig. 2 following one another in inverse order of the magnitude of the several loads. But, although the initial slope of the curves diminishes with increasing loads, the "turning points" where the ratio of the contraction to the magnetic field is a maximum occur later with great than with small loads, so that in a field of 360 the order of the relative values of the contractions for the three smallest loads is actually reversed, the contraction being greatest with the heaviest load and least with the lightest. It appears probable that, if the experiment had been carried far enough, the curve for 1,400 kilos would have crossed one if not all of the three curves lying below it. Whether the two remaining curves for 1,890 and 2,310 kilos would behave similarly is more doubtful. Possibly they would have become parallel to the horizontal axis before the others were reached.

I think it may fairly be assumed that if the experiment could have been made with the wire quite unstretched, we should have obtained a curve having a steeper initial slope than any of those in the diagram, but also reaching its turning point sooner, and therefore intersecting at least three or four of the others.

In Fig. 3 the results for nickel are presented in a somewhat different form, the curves showing the magnetic contractions of the wire under various loads in certain constant fields. The values for no load are taken from the results of an experiment with an unstretched nickel rod 0·3 cm. in diameter, and the portions of the

* Abstract of a Paper read April 24, 1890, before the Royal Society.

Digitized by Google

curves which depend upon the accuracy of these values are distinguished by dotted lines. It will be seen, however, that these portions are not of much importance. From these curves we at once see that in a field of 125 units, increase of load always causes decrease of magnetic contraction. In a field of 185, magnetic contraction increases as the load is raised from nothing up to about 700 kilos. per square cm., again decreasing with greater loads. And in a field of 360 units this singular reversal is exhibited in a still more marked degree, the maximum magnetic contraction occurring with a load of about 950 kilos per square cm.

The reversal phenomena observed in connection with the magnetic contraction of nickel are strikingly analogous to those which occur in the magnetisation of a stretched iron wire, and which are commonly associated with the name of Villari.*

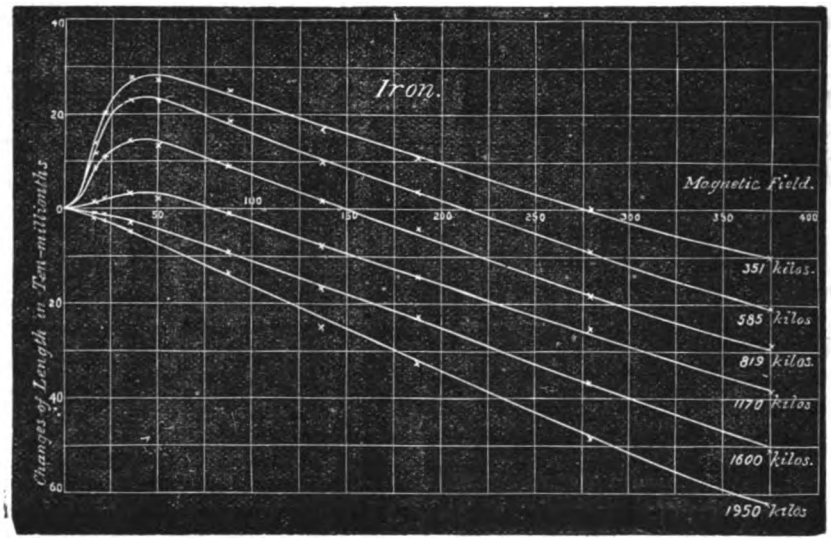


FIG. 1.

Prof. J. J. Thomson has shown† that the Villari effect is dynamically connected with the changes of length undergone by an iron rod when magnetised, an iron rod being lengthened in a weak magnetic field and shortened in a strong one. Now, cobalt behaves oppositely to iron in this respect, a rod of cobalt becoming shorter

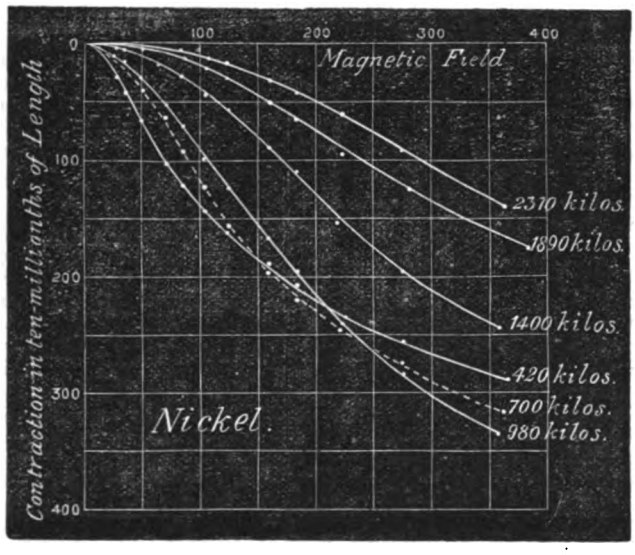


FIG. 2.

in a weak field, longer in a strong one.‡ Prof. Thomson, therefore, predicted that a Villari reversal would be found to occur in cobalt, and that it would be of the opposite character to that in iron. Some experiments made by Mr. Chree* with a cobalt rod under pressure gave results in accordance with Prof. Thomson's expectation.

But no reversal of the effect of magnetisation in diminishing the length of an unstretched nickel rod has ever been observed. Such a rod always becomes shorter in a magnetic field, whether strong or weak. It appears to attain its shortest length in a field of about 750 units, but it does not pass a minimum and become longer again in stronger fields, like cobalt. Applying Prof. Thomson's reasoning, therefore, to the case of nickel, we should expect that it would be found not to exhibit any Villari reversal, either of the nature of that in iron, or of that in cobalt. Both Sir William Thomson and Prof. Ewing have, in fact, looked for one and failed to find it. But in a Paper read at the meeting of the Physical Society on March 21, 1890,† Mr. Herbert Tomlinson gave an account of some experiments which, as he believed, showed that a Villari critical point really existed in nickel, though it was only to be reached by the application of comparatively great magnetising forces. I venture to suggest that Mr. Tomlinson's results may possibly be brought into harmony with Prof. J. J. Thomson's mathematics by consideration of the experiments described in the present Paper: for, as I understand Prof. Thomson's argument, he has hitherto

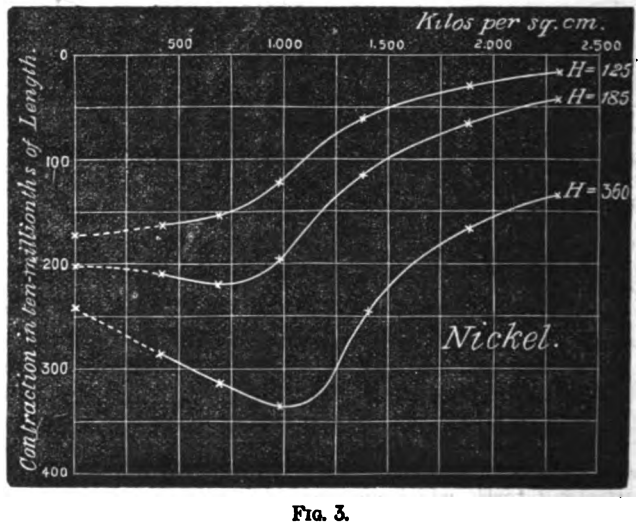


FIG. 3.

taken no account of the effects of mechanical stress upon magnetic changes of length.

Cobalt.—The results for cobalt show that the changes of length which this metal undergoes when magnetised are almost, if not entirely, unaffected by tensional stress, at least within the limits of the experiments. Having regard to the very marked influence of tension upon iron and nickel, this cannot but be regarded as a most remarkable fact.

* Poggendorff's *Annalen*, 1868. *See* also *Encycl. Britann.*, vol. 15, p. 269. When an iron wire subject to a magnetising force in the direction of its length is stretched by a certain force, the magnetisation of the wire is increased or diminished according as the magnetising force is less or greater than a certain critical value (depending upon the magnitude of the stretching force) for which stretching produces no effect.

† "Applications of Dynamics to Physics and Chemistry," p. 54.

‡ *Phil. Trans.*, A (1888), p. 227.

* "Roy. Soc. *Proc.*" vol. 47 (1890), p. 41.

† *The Electrician*, April 4, p. 547.

Digitized by Google

Summary of Results.

Iron.—Tension diminishes the magnetic elongation of iron, and causes contraction to take place with a smaller magnetising force.

Nickel.—In weak fields the magnetic contraction of nickel is diminished by tension. In fields of more than 140 or 150 units, the magnetic contraction is increased by tensional stress up to a certain critical value, depending upon the strength of the field, and diminished by greater tension.

FIG. 4.

Cobalt.—The magnetic contraction of cobalt is (for magnetic fields up to 500 C.-G.-S. units and loads up to 772 kilos. per sq. cm.) practically unaffected by tension.

CENTRAL LONDON RAILWAY BILL.

HOUSE OF COMMONS.—THURSDAY, April 24th.

On Thursday, after the police evidence, witnesses were called as to the effect of the City and Southwark Subway upon the buildings along the route.

Mr. DOUGLAS YOUNG, Surveyor, of King William-street and Clapham, said that he had been engaged since the commencement of the City and Southwark Subway work in advising them professionally, and in purchasing the lands required for their scheme. He had also surveyed all the buildings along the line of route, and taken photographs of upwards of 500 buildings. None of the buildings along the line of route had had their stability affected. There had been some damage done where it affected the property facing the brick tunnels—some eight or ten cases. There had been no obstruction to traffic.

Sir SELWIN IBBETSON, M.P., gave evidence that he and some of his friends had deposited over £100,000 for the purposes of this Bill. He and his friends had gone very carefully into the whole matter, and they were satisfied that it would be successful.

Sir BENJAMIN BAKER was next examined. He said that he had been consulted with reference to big railways in Berlin, Vienna, Paris, and New York. He had carefully considered this scheme. Projects for railways along Oxford-street had been brought forward many times during the past 20 years, but it was only recently that he thought the time had been ripe for its being undertaken. A short railway of this type—a small tube driven by a shield—was constructed in New York 18 years ago, and was worked for two years as an experiment. But it was found that elevated railways were much cheaper, and they built them in lieu of 10 feet underground railways. The present scheme was the only plan in which future railways in the heart of London could be constructed. No one would ever allow an elevated railroad to be constructed, and an ordinary railroad, worked by locomotives, with all the ventilation blow-holes, would be impracticable on account of the cost. This line would be perfectly free from causing noise or vibration. They could attain a speed, including stoppages, of 14 miles an hour; and that would be more than two and a-half times as fast as a tramcar, twice as fast as an omnibus, and about one-sixth faster than the Underground Railway. There was no interference with the streets during the construction of the works. In that respect it differed entirely from the other underground railways, where the streets were broken up. Here there was no ventilating openings, and no interference with public convenience. He had not the slightest doubt that this railway, if constructed, could be successfully worked by electricity. The electric motor was as absolutely certain in its working as the telephone or the electric telegraph.

FRIDAY, April 25th.

On Friday, Sir BENJAMIN BAKER was recalled and further examined by Mr. Freeman for the Bill. Witness said that his experience in America of electric railways and tramways convinced him that they had passed beyond the region of experiment. There were 1,500 miles of electric railway constructed, and about 3,000 locomotives at work. In America they were subjected to very great difficulties and practical inconveniences from which they would be free in the Central London Railway. In America they had all the disadvantages of snow and frost, and the constant interruption from vehicles crossing the railway. Being in a tunnel the Central London was less difficult and less dangerous to work. With regard to the City and Southwark Railway, they had two types of locomotives, and a third was practically complete; each was an improvement on the other, and he thought they had arrived at practical perfection. In many of the electric motors gearing is used—steel-toothed wheels—and in others pitched chains; but we are proposing to work direct without any gearing or without any pitched chains. Therefore the electric motor that we shall use is an infinitely superior machine to an ordinary locomotive, and infinitely less liable to get out of order or to have any accidents.

Do you entirely agree with Mr. Greathead that in substituting iron tube stations for brick stations the danger of subsidence will be done away with?—There will be no risk whatever with the shields and iron-lined stations, but it involved a large additional expense. The precautions we have taken on this line in order to avoid damage to property, or any inconvenience to the pipes or otherwise, has involved a total expenditure of about £400,000. Cast-iron is adopted throughout. I was engaged on the Metropolitan Railway from Moorgate-street round to the Mansion House, and also on other lines in the metropolis. Compared with anything which was carried out on those Metropolitan Railways, the proposed works of the Central London Railway are insignificant. If we get amongst the sand and gravel we are prepared to work by compressed air; and then we can work as safely in gravel charged with water as we can in London clay. On the Underground Railway, when we were in wet sand and gravel, we pumped and dried the ground first by pumping.

Could you give us any information with regard to risks. The witness then read an abstract from an article by Mr. Sprague (*Electrician*, March 7, 1890, p. 443), in which the author said: "The objection raised by the municipal authorities in some instances on the ground of danger to life from the current may be met by the assertion that, although 80 lines are now in operation, and numerous shocks have been received by the *employés*, no serious injury has ever ensued; so that it may be safely asserted that a continuous current having an electromotive force of 500 volts is not dangerous to life. Grades of 12½ per cent. to 14 per cent. have been ascended by a motor car pulling a tow-car; in crowded cities the speed has been increased 50 per cent., and in the suburbs speed of 20 miles an hour are made."

Is it not the case that death has resulted in New York and elsewhere in the United States from electric wires?—Oh, yes; it happens very frequently. The tension is about 2,000 volts. I myself saw a man killed. He was upon a post changing a wire or doing something to a conductor, and he got the shock and fell down into the street. The Board of Trade have limited the tension in the case of the City and Southwark to 500 volts, and in another place to 600 volts.

Sir JOHN FOWLER was next examined in support of the Bill. In answer to Mr. Saunders, Q.C., witness said that he would pledge his reputation as an engineer that if they constructed the tunnel by a shield and iron tube they would practically get rid of all danger of subsidence. The experience with electricity in American railways is just as good as if the experience were gathered in London.

Does electric traction get over the difficulty of the impurity of the atmosphere?—You have perfect ventilation. Every train changes the air, and it comes in and goes out at the station by the operation of the working of the train itself.

MONDAY, April 28th.

On Monday, Mr. LITTLER, Q.C., opened the case for the trustees of the Paddington Estate, in opposition to the Bill. He said the property of his clients represented a money value of eight millions, and the fact that they were opposed to the Bill was a striking piece of evidence against the utility of the scheme to a portion of the district which it proposed to serve. He suggested that the promoters in thus seeking to push forward a scheme, of which the only precedent was one—the City and Southwark—as yet untried, were anxious to secure possession of the ground; and that they would in another Session come to Parliament for the alteration of their plans. The promoters of similar schemes, satisfied of the imperfection of their schemes, had withdrawn their Bills; and it was owing to the inherent badness of this scheme that competitors had determined to let it fall by its own weight. As to the proposed working of the railroad from a centre, that had been tried in other cases by ropes or atmospheric power, and had to be given up. Electricity had not been tried and was, he contended, impracticable. To compare the American street railways with the present scheme was as reasonable as to say that, because a watch went by a mainspring, you could work a railway by clockwork. Having regard to the entirely novel character of the scheme, the proper course would be to appoint a Select Committee or Royal Commission to inquire into this and similar modes of working, rather than a Committee who were tied down to the consideration of the one matter before them. Such had been the course when Parliament originally dealt with intercommunication in the Metropolis, and he asked the Committee to remember that Lord Derby's Hybrid Committee reported against a railway running down Oxford-street. To hand over the streets to the promoters for an indefinite time was an act of injustice to the owners of property; and Mr. Greathead, in his evidence, was bound to admit that, notwithstanding the greatest precaution, there was danger to buildings in his scheme. With the large capital sought for, and the enormous competition for traffic in the Metropolis, the scheme could never pay. For these reasons he submitted that the Bill should be rejected.

Mr. CHARLES GIBBONS, C.E., said he had visited the works of the Southwark Subway, and found that damage had been caused all along the line, especially at the stations. From an examination of the soil he apprehended similar damage if the scheme were carried out. As to

Digitized by Google

the proposed working he thought it unfair to tax that particular part of London round the Queen's-road generating station with the concentrated work for the whole length of the line; and he considered the generating station might, with advantage, have been taken much further west.

Mr. JEUNE, Q.C., addressed the Committee for the Ecclesiastical Commissioners and the Paddington Vestry. Having adverted to the improbability of such a railway paying its shareholders, he proceeded to deal with the question of construction and working. Although Sir John Fowler and Sir Benjamin Baker—perhaps the greatest engineers of the day—expressed their confidence in the undertaking, it was an undertaking wholly different in nature and working from anything in which they had been engaged before. Great engineers had erred before now, and the eminence of the two gentlemen in question did not afford that safeguard which it would do if the matter was one in which they had had real experience. This railway was an electric railway, or nothing; and on this he pointed out that as to the cost of working there was nothing but the guess of Mr. Mather that it could be done for 9d. If the promoters had only waited until the City and Southwark was opened, the cost would have been perfectly well known, and this important question solved. As to the loss of power in working, they were absolutely at sea, and the two leading witnesses for the promoters were entirely at sea on the subject. Dr. Hopkinson said that the loss would be about 33 per cent. Sir Benjamin Baker, speaking of American railroads, said the loss was about 50 per cent.; and it was put to another witness by Mr. Littler that when you got to actual experiments on a railway for the purpose of testing the motors, the loss rose as high as 85 per cent. And this was against a loss of 15 per cent. in the case of steam. There, then, was a matter of vital importance in which the Committee was left in the dark. The information afforded on other matters, too, was so scanty that he urged it contained no justification for the Bill.

TUESDAY, April 29th.

Mr. JEUNE, Q.C., further proceeded to address the Court on behalf of the Ecclesiastical Commissioners; and Mr. Cripps, Q.C., was heard on behalf of Lord Portman, the vestry of Marylebone, owners of property in Oxford-street, frontagers in Holborn, and owners and occupiers of frontages on the City portion of the line. The first point put forward as a basis of opposition was that there was no case of public necessity for the line from a traffic point of view. The learned counsel went on to contend that the tendency of traffic was to increase by means of overground conveyances, such as omnibuses and trams, rather than by underground railways; and the increased number of passengers travelling by the Metropolitan and District Railways was no proof of the necessity for this line. He would also say that the experience in connection with other electric railways did not bear out what had been put forward by the promoters as to the expense, and contended that it would be impossible to work this line on a remunerative basis. As regards what had been said about the fact of there being electric railways working in America being a justification for such a line as this, one might just as well go to America and say that because a Committee in this country had sanctioned the City and Southwark Subway that was a justification for the adoption of the same system in America.

Mr. Edward White, Chairman of the Parliamentary Committee of the Marylebone Vestry, Mr. James Marshall, and others, were then examined.

WEDNESDAY, April 30th.

Mr. WILLIAM BOURNE LEWIS, M.Inst.C.E., examined by Mr. Pope, Q.C., said he had had considerable experience in the construction of railways and other public works. He did not think the proposed railway could be constructed in Cheapside or the Poultry without damaging the buildings. The risks were real to such important buildings as St. Paul's Cathedral and large warehouses and business premises. The fear of disasters from the construction of such railways as this had been increased after an inspection of the City and Southwark Subway, where considerable damage had been done, notwithstanding that great skill had been shown in the construction of the line. He feared that damage would be done to Bow Church; it was his opinion that the driving of the tunnel might cause subsidences along the line of route, and he anticipated injury to the Mansion House. As to Messrs. Mappin and Webb's premises, it was quite possible that the whole building might come down. The National Safe Deposit Company's premises were founded at a depth of 42ft., and then a layer of concrete 6ft. in depth had to be placed there before the building could be built, owing to the indifferent state of the subsoil. He submitted that the risks were so real and the injuries that might result so serious that further experiments should be made before such important thoroughfares were handed over to the promoters. No tunnel had been made in the London clay at a depth of 100ft. without subsidence resulting. In saying this he had in his mind brick tunnels. When the Metropolitan Railway was constructed along Cannon-street the houses there were all underpinned. He had had considerable experience in America, and he knew the tunnel under the Hudson River, in the case of which the water had broken in on more than one occasion, and several people had been drowned. Personally, he would like to see this scheme carried out; but he did not consider that it would be safe, in the present state of engineering experience in these matters, to carry out this line. It was merely an experiment.

Cross-examined by Mr. Saunders, Q.C., he still persisted in that assertion, in the face of the successful experience in the case of the Sinclair Tunnel under the St. Lawrence and the City and Southwark Subway in this country. He did not know that in the latter case some of the cracks which were attributed to the subway were found to have existed before.

Further evidence having been given by Mr. JOHN BELCHIER, architect and Mr. R. T. KINGHAM, the secretary of the London General Omnibus Company,

Mr. BIDDER, Q.C., proceeded to address the Committee on behalf of the Duke of Portland in opposition to the Bill.

THURSDAY, May 1st.

Sir JOHN FOWLER having been recalled and further examined by Mr. Pember, Q.C., as to the estimates,

Mr. ALFRED LYTTELTON proceeded to address the Committee on behalf of the Duke of Westminster in opposition to the Bill. This line had been put forward by Sir Benjamin Baker in the light of his experience of electric lines in America; but he admitted that he was not an expert in electrical matters, and left the details of the system to be dealt with by Sir John Fowler; but when he came all he did was to produce the advertisement sheets of certain railways in America, and no American engineer had been called to speak to the practical working and expense of the electrical lines there. A great source of danger in the present case lay in the fact that there was to be only a single generating station.

Mr. P. C. CLARK, F.R.I.B.A., surveyor to the Fishmongers' and Cordwainers' Companies, then gave evidence in support of the case of the Duke of Westminster, and described the character of his property, much of which, he said, had been rebuilt at a cost of £70,000 to £80,000.

THE RAILWAY RATES INQUIRY.

The Board of Trade inquiry respecting the proposals of the railway companies for the classification of merchandise traffic under the provisions of the Railway and Canal Traffic Act of 1888, was continued on Friday last before Lord Balfour of Burleigh and Mr. Courtenay Boyle, C.B., the Parliamentary and Assistant Secretaries of the Board. The traders' proposals in reference to Class 2 were under consideration.

FRIDAY, April 25th.

Electric Cables.

Lord BALFOUR OF BURLEIGH asked if it was agreed that electric cables should be inserted in the classification as hardware.

Mr. R. H. TWELVETREES (Great Northern) objected on behalf of the railway companies, but said they were included in the list which the traders wished to have included as hardware.

Mr. IMPEY asked the Court to allow the item to be struck out as far as the Birmingham Association were concerned. It had been put in under a misapprehension, and the traders had no wish to advance any arguments in favour of the proposal which had been submitted.

Lord BALFOUR OF BURLEIGH: Do not the electric and the allied trades appear upon this?

Mr. HOWELL, who represented the traders generally, replied in the negative. The objections of the electric and allied trades would come on in a subsequent class.

Electric Insulators.

Mr. COURTENAY BOYLE asked if electric insulators were hardware.

Mr. IMPEY said that was another point which the traders did not wish to press. These electric articles had been put in under a misapprehension.

LORD BALFOUR OF BURLEIGH asked if electric insulators were classed at all.

Mr. TWELVETREES said they were in Class 2, under the heading of electric accumulators.

Mr. COURTENAY BOYLE said an insulator was not the same thing as an accumulator.

Mr. WILKINSON said they would be charged under the head of earthenware.

Mr. COURTENAY BOYLE said he knew enough about electric insulators to know that they need not be earthenware or china or anything else.

Mr. TWELVETREES said they were in Class 2 of the clearing-house classification. Electric insulators, glass, were in Class 2; and telegraph insulators, packed, in Class 1. The companies had adopted the term electric insulators to cover the two, and had put them in Class 2.

Mr. COURTENAY BOYLE: And that is meant to cover the little bobbins, if that is the proper phrase, which guard the wires on the posts? Is that so?

Mr. TWELVETREES: Precisely.

Mr. COURTENAY BOYLE: If you are satisfied, well and good; but electric insulators mean other things besides that.

Mr. IMPEY repeated that, so far as the Birmingham Association were concerned, they did not press their objections with regard to either of these items.

TUESDAY, April 29th.

Telegraph Insulators.

On Tuesday the classification of "telegraph insulators" was considered.

Mr. A. P. TROTTER said he had to object, on behalf of the Electrical Trades Section of the London Chamber of Commerce, to the omission of this item. The objection of the railway companies was that they should be classed with electric insulators in Class 2. "Electric insulators" was a vague term, and he could not say what it meant; but "telegraph insulators" was a well-known term, which it was scarcely necessary that he should describe. Telegraph insulators were generally made of earthenware,

Digitized by Google

and they were sent out with the spikes fastened in, forming a rather heavy article. It was in the Railway Clearing House classification in Class 1. He thought they were always packed, and he had nothing to say except with regard to packed insulators. The traders objected to their being put with electric insulators, which were commonly made of glass. In America they were of glass, but in this country earthenware insulators were always used for telegraph work, and the article was packed in casks.

Lord BALFOUR OF BURLEIGH: If you put in the words "telegraph insulators" would it not affect insulators in Class 2, and would not the makers of electric insulators, which you say are of glass, claim to come under "telegraph insulators"?

Mr. TROTTER: Glass insulators are not used in this country by reason of the climate. In this country earthenware insulators only are used.

Lord BALFOUR OF BURLEIGH: Although glass insulators are not used in this country, it may be that they are made in this country and sent elsewhere.

Mr. TROTTER: We should have no objection to have "telegraph insulators, not glass, packed." That would satisfy the conditions.

Mr. HARRISON, for the railway companies, said that what the companies knew as telegraph insulators were the small earthenware blocks; they had no objection to place "telegraph insulators, earthenware, packed," in Class 1.

Batteries, Packed.

Upon this item, Mr. HOWELL, solicitor, said the electrical trade were satisfied with the railway companies' explanation. They would stand in Class 3.

Dynamos and Electrical Machinery, Packed.

Mr. TROTTER: In this case, also, we accept the replies made by the railway companies. They are not included in the classification. They go as machinery. We objected to the omission, but we accepted the explanation that they will go as machinery.

Electric Storage Batteries.

Mr. TROTTER: We also accept the replies of the railway companies in this case.

ELECTRIC LIGHTING AT BRIGHTON.

LOCAL GOVERNMENT INQUIRY.

On Tuesday last Mr. Codrington, M.I.C.E., commenced an inquiry at the Town Hall, Brighton, on behalf of the Local Government Board, into the application of the Corporation to borrow £32,500 for the purposes of electric lighting and £4,500 for the purchase of land for a storeyard. Mr. Boxall appeared for the Town Council; Mr. Sutton opposed on behalf of a number of ratepayers representing a rateable value of £272,000; Mr. G. J. Castle, Q.C., opposed on behalf of the Brighton and Hove Electric Light Company; Mr. H. J. Verrall opposed on behalf of Colonel Tamplin, Mr. G. Attree, and Mr. G. F. Attree; Councillor Blaker said he opposed as a member of the Town Council.

Mr. BOXALL, in opening the case for the Corporation, said the Corporation of Brighton had carefully watched the progress of lighting by electricity for the past ten or twelve years. So far back as 1879 or 1880 they carried out experimental works. In 1881 they had a large part of the Marine-parade lit up by Siemens Brothers. In 1881 and 1882 the Pavilion and Dome and Corn Exchange were lit by the British Electric Light Company and the Brush Electric Light Company. In 1882 the Corporation obtained a Provisional Order, and it was under that Order, with some modification, that it was proposed to supply the town with electricity. In 1883 a small installation of about 400 lights was made at the Pavilion, and in 1884 that was extended to the Dome Assembly Room and Free Library. In 1884 they obtained a report from Dr. Gooch as to lighting the Front. In 1886 and 1887 the work at the Pavilion was taken down and relaid with extensions, and that installation was now in full working order, and was now in the hands of the Corporation. In 1889 the Company, which had been supplying some part of Brighton with overhead wires, having no statutory powers whatever, gave notice of their application for a Provisional Order. The Corporation withheld their consent. An inquiry took place in April, and in May a correspondence took place between the Board of Trade and the Corporation, in which the Corporation stated that within two years they would put their electric powers in force. In pursuance of that undertaking the Corporation proceeded to get the best advice as to the lighting. They got a report from Mr. Shoolbred. On December 31st he made a report, and on January 23rd it came before the Town Council, and a resolution was passed which was the basis of that application. That resolution was confirmed by a special resolution, arrived at on March 3rd, 1889, as to an increase of area. As regarded the loan, the rateable value was £664,048. The sum borrowed must not exceed £1,328,096. The present debt was only £263,575, so that there was a margin of £1,064,000 available to the Corporation at the present time.

The INSPECTOR said he should like to know from the Town Clerk whether the debt on the Waterworks was included in this.

The TOWN CLERK said this was under a special Act of Parliament. The debt was about £500,000.

The MAYOR (Alderman Manwaring), examined by Mr. Boxall, said that during the past 10 years the Corporation had been directing its attention to electric lighting. They had consulted a number of engineers, and had made several experiments; but they thought the time had now come when they should undertake the lighting of the town. They had made close inquiry as to the cost and prospects of the installation. They had obtained reports from more than one engineer, and he felt morally certain that the works would soon require extension. From what he knew he considered it important that the Corporation should themselves have the control and the laying down of the electric wires and the supplying of the light in the town.

Cross-examined by Mr. CASTLE as to whether he thought it fair that the Brighton Company having done the work well for nine years and benefited the town, the Corporation should come in and take the business just when they thought it likely to be a commercial success, without compensation.

The MAYOR said he was of opinion that the Company had no right to any compensation.

Mr. SUTTON then produced a petition, which he said had been signed by 10,000 ratepayers, against the Corporation undertaking the electric light.

Mr. J. G. SHOOLBRED was then called. In his opinion the system best suited for the requirements of the district was the low-pressure system with continuous current, supplemented by storage batteries. The system was in use in London at Kensington, at Chelsea, at Westminster, at St. James's, Pall Mall, and also in the provinces at Liverpool, Leamington, Bradford, and possibly at other places. So far as he knew, the results in these places were satisfactory. The installation proposed for Brighton would light 5,000 sixteen-candle lamps at one time, and 10,000 lamps would be attached. The total cost he estimated at £30,000, and he thought the installation would be sufficient for the present requirements of the extended area, while it would also admit of extension without difficulty if there were a larger demand. He was aware it was contemplated to charge 6d. per unit, and he recommended that charge himself.

Mr. CASTLE: It has been suggested by our own witnesses that £6,000 ought to be put down for the buildings, and not £3,000; and that when the Corporation put them up they will cost nearly £10,000.—I should be surprised if they did.—Witness: continuing, said he had calculated that 5,000 lamps would use 402,000 units.

Mr. CASTLE: Would you be surprised to hear that we have 5,000 lamps installed as compared with your 10,000, and they only produce 127,000 units?—I should.

Can you give me the figures on which you get the 402,000 units?—The figures are detailed above in the report.

Mr. CASTLE: Can you tell me what distance you can work from your station on this system?—It depends on the pressure to which you limit yourselves, and what you put into your mains.

Can you work a mile or three-quarters of a mile?—A mile is a long distance to work a feeding main.

Cross-examined by Mr. VERRALL: He had made no estimate of the numbers of persons or houses likely to use the electricity. He should consider that on an average 80 to 100 lamps would be used in each house.

Mr. R. E. CROMPTON was then called. He believed that under the existing circumstances the Corporation were wise in undertaking the supply of electricity for themselves. He thought the work might be undertaken with safety at the present time. He thought £30,000 sufficient for the installation, and he generally approved of the scheme and the figures. He considered the low-pressure system most economical, as by it they were able to lock up the central station at midnight, and work with two shifts of men in the winter, and one in the summer, instead of three all the year round, making a considerable saving in labour. The main feature in the price at which the unit could be supplied would be the amount of consumption, as there was so much fixed expenditure. As to the renewal of plant, after careful consideration, and after taking the opinion of several gentlemen, and with a Committee including Sir Frederick Bramwell, they fixed on the plan of setting aside every year a certain percentage on each class of plant, and from that deduct any sum that happened to be paid for repairs during the year, and carrying the balance over.

Cross-examined by Mr. CASTLE, the witness said he did not understand that for the purpose of rating it had been decided by an Act of Parliament applying to the Metropolis that 33 per cent. should be allowed for the depreciation of buildings and machinery. He thought 4½ per cent. sufficient. For machinery made of cast-iron or something of that sort 10 per cent. might be written off for depreciation, because the original cost was low; but a dynamo was a very expensive machine, and therefore the repairs bore a small proportion to the original cost. For 5 per cent. on cost price makers would keep engines in order for ever. At Chelmsford the witness mentioned that his firm was trying to get 1s. a unit for private lighting, and they were getting about 2d. a unit for public lighting. They gave the public light practically for nothing in order to get the private lighting. The average cost of public and private lighting put together would be about 7d. per unit, which would about cover the expense. He should have thought that if the Brighton and Hove Company had been supplying the place well they would have had more custom. He would naturally feel strongly upon the matter if he had been supplying a place for eight or nine years, and the Corporation then stepped in; but as to whether it was right or not for the Corporation to do so was another thing. As to whether the electricity could be supplied at 6d. per unit must depend upon the consumption. He should estimate that 100,000 units could be supplied at 7·69d. per unit. He did not think there was any sinking fund for replacement, but if there was it would have to be added, and if the electricity could not be supplied for the money which was proposed to be charged, the deficit, he presumed, would have to be made good out of the rates. He supposed the Corporation considered there was a demand for the electric light beyond the customers of the present Company. He had always understood that there had been a great demand for the electric

Digitized by Google

light in Brighton. He should think shops would use it at 7d. per unit. It was comparable to gas at that price.

In answer to Mr. VERRALL, the witness said that about 50 lamps on the average would go to a house, so that the Corporation would supply about 200 houses.

Mr. ALEXANDER SIEMENS said he had considered the system of supply which the Corporation proposed to adopt, and he thought it was one which was best adapted to the circumstances in Brighton. His firm had tendered upon the specification of Mr. Shoolbred.

Cross-examined by Mr. CASTLE, the witness said that he did not know sanction had not been obtained for the borrowing of the money when he tendered. He thought the work could be done for Mr. Shoolbred's estimate, and if the Corporation would give him the order now he would take it.

Mr. CASTLE: And keep it in repair for ever at 5 per cent.?—I believe 5 per cent. on £30,000 would about cover it.

Continuing, witness said that he had gone into the estimate to see whether the undertaking would pay or not. He had allowed 5 per cent. for renewal fund, and 5 per cent. for repayment of capital, and 10 per cent. for depreciation of machinery. Those three items amounted to £3,800. Then he put labour at £1,700; coal (25s. per ton), £1,500; sundries, £300. These items amounted to £3,500, against Mr. Shoolbred's £4,290.

Mr. CASTLE pointed out that Mr. Shoolbred had items amounting to £1,990, against the witness's £800, and that Mr. Siemens had not made an allowance for rates and taxes. The witness said that on his estimate 4d. a unit would pay, so that left a good margin. He had based his estimate on the assumption that 400,000 units a year would be used. He at the same time admitted that he had only allowed 1½ per cent. for repayment of capital.

This concluded the evidence on behalf of the Corporation.

Mr. T. A. GOODMAN, solicitor, Brighton, gave evidence to the effect that he was engaged on behalf of various ratepayers, that he received instructions from Mr. Joseph Wood, and produced a petition signed by 10,000 ratepayers.

The inquiry was then adjourned until Wednesday morning.

WEDNESDAY, April 30th.

On the inquiry being resumed, Mr. CARPENTER, an ex-member of the Town Council, addressed the Inspector, protesting, as a ratepayer, against the line pursued by the Town Council, contending that they were not justified in placing a heavy burden on the town for the supply of a little district.

The matter of the petition presented the previous day was then gone into.

Mr. BOXALL said they had given their attention to the petition, and, selecting the eleventh sheet from the end, had made a careful investigation. On that sheet there were 26 names on each column. On the left-hand column 12 were names of persons on the rate-book and 14 names not on the rate-book. It was represented to be a petition of 10,000 ratepayers. There were 176 sheets of it, and room for 52 names on each sheet, so that even if all the sheets were full, as they were not, there could not be 10,000 on the petition.

Mr. SHOOLBRED, who was recalled, said he estimated the average consumption on weekdays at 20,800 hours.

Mr. CASTLE, addressing the Inspector on behalf of the Company, said they were there because they had been providing the electric light in Brighton for years, and because they thought the Corporation were treating them unfairly and ungenerously in now attempting to come forward and to a certain extent take away the business which the Company had built up. He commented on the fact that the Corporation had done nothing since they obtained their Order in 1883. The Company, however, stepped into the breach, and supplied what was the cheapest and most economical form of electric light for a large area. Contrasting the two systems, he claimed that the alternating system as adopted by the Company was the best. Mr. Castle urged that the Corporation were going into an expenditure of £30,000 when the undertaking could not pay expenses. He asked the Corporation to delay the work until November, when the opinion of the ratepayers could be obtained. Dealing with the question of overhead wires, he said the Corporation refused to meet them in any way, and that was the reason the Board of Trade refused the Provisional Order asked for by the Company so as to enable them to put them under the ground. The Company, said Mr. Castle, had actually been led on by the Corporation from time to time to do their work, and now the Corporation refused to meet them in any way. He contended that the evidence failed to show that the Corporation were acting with the general consent of the inhabitants, and claimed that they ought to have called a public meeting.

Mr. W. LOWRIE, consulting engineer to the Brighton and Hove Electric Lighting Company, said that 10,000 lamps would not use as much as 402,500 units per annum.

At the close of this evidence the question of the petition again cropped up, and Mr. TALBOT stated that on page 7 there were 25 names on one side and 26 on the other. Of the 25 names seven were not on the rate book, and of the 26 there were four not on the rate book.

Mr. SUTTON then addressed the Inspector, urging that the ratepayers had no opportunity of expressing their views upon the question whether the Corporation were or were not to carry out the electrical power conferred upon them by Parliament. He described the scheme as a very risky one, especially as in order to succeed it would be necessary to cut out the present Company.

Mr. BOXALL next replied on behalf of the Corporation.

The inquiry then closed.

CORRESPONDENCE.

LIGHTNING IN ELECTRIC LIGHT LEADS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The enclosed letter from a correspondent in Portugal reached me shortly after the recent meeting of the Institution of Electrical Engineers, where I had been surmising that such occurrences might be not uncommon. Although the damage done was only slight, the account is perhaps of sufficient interest for insertion in your paper.—Yours, &c.,

Liverpool, April 26, 1890. OLIVER J. LODGE.

(COPY OF LETTER.)

Companhia de Luz Electrica, Oporto, Portugal, April 19, 1890.

To Prof. Oliver J. Lodge, University College, Liverpool.

SIR: Though personally unacquainted with you, I take the liberty of sending you a specimen of a lightning-injured wire, and a statement of the circumstances which seem to me to go to confirm your views on the lightning-rod question.

The electric light system here is operated by means of both overhead and subterranean wires on the low-tension direct system, and the station stands well in the middle of the city and its district, in a roughly pentagonal space bounded by five streets.

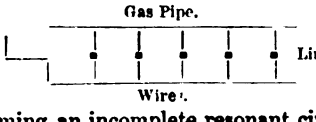
About 9 p.m., on the night of April 17th (Thursday last), a severe flash struck apparently into this space; but, dividing between many telephone wires two or three lightning conductors and tall houses very wet from four days' nearly continuous rain, did no structural damage. The report in the electric light works followed instantaneously after the flash. Nothing was observed on the lightning protectors of the lines, and no damage was done to any part of the apparatus or machinery.

But two faults were caused in installations within 100ms. of the works, the wire I enclose being one. In this case the shop is supplied from an overhead line. The damaged wire was inside a tubular arm on a "combination" (gas and electric) pendant, and the pendant gave a good earth through gas pipes. The people in the shop say that the lamp gave two sharp cracks and then went out. The lamp, however, was not damaged. It merely went out because the discharge ruptured the wire. No other wire or lamp in the shop was damaged, and the faulty wire was at the extreme end of the shop, as far from the entrance of the leads as could be—perhaps 8ms. or so. The brass tube enclosing the wire showed no injuries externally. One end of the wire earthed on the pipe, and the fault was detected by the insulation test of the following morning, before any complaint reached me. The overhead line runs very low, and is crossed by many telephone wires at up to 10 or 15ms. greater altitudes.

The other case occurred in a shop connected to the underground line. A spark passed between an electric bell wire and a twin wire leading to a single lamp, at a spot where the bell wire crossed the light conductor. All these wires, the P. and N. light conductors and the bell wire, were ruptured, the bell wire losing about 1cm. by volatisation or fusion. The insulations showed no signs of overheating, and the fuse wire in the cut-out was not fused. Surrounding woodwork was slightly scorched and smoked at the point of rupture of the wires.

This case is rather curious. The bell wire and its circuit is wholly within the house. The electric lighting line is entirely underground, and no discharge could have got into it from an overhead line without passing through the works and running the gauntlet of two lightning protectors, one on each line terminal. A telephone wire runs near the bell circuit inside the house, and this wire got some discharge, the aerial line parting outside the house, and the instrument being rendered useless.

Does it not appear probable that the spark which passed between the bell and the light wire was due to an induced current set up in them, or perhaps to a resonance effect? It seems impossible that any direct lightning discharge can have got at either circuit, at least without leaving behind it unmistakable traces. And in the first case, though not clearly impossible, it seems to me improbable that any part of the actual flash reached the line, it being so well protected by the higher network of telephone wires. Also any lightning flash would pretty certainly have done much more damage, and would hardly have picked out the last pendant in the shop to burst through in. In this case the main gas pipes run down one side of the shop, the electric light wires down the other, thus in plan—



perhaps thus forming an incomplete resonant circuit, of which the fault formed the spark gap.

Digitized by Google

On the same night, probably a few minutes later, a flash struck near or actually on to a small theatre lighted from our circuit. This theatre is roofed and walled with galvanised iron, so that any entry of a flash would seem impossible. But a lamp in the manager's office burst: short-circuiting across the platinums inside at the moment of the flash. This is an accident that sometimes, but rarely, occurs to a lamp at normal pressure; nearly always, however, to new lamps, whereas this lamp was old. It happens that the lead and return of this particular lamp do not run together, but form a loop; in fact, the lead comes off one circuit, and the return off another, the two circuits being in separate casings, parallel, about 3 or 4ms. apart. Might this have been another case of a resonant circuit? Anyway, something raised the potential difference between the two wires considerably at the moment.

No complaint has been received from any other installation on the same circuit, and its insulation was normal on the following morning. It is, I should say, an overhead circuit, about 350ms. in length, the theatre being at the far end from the works.

My apology for troubling you must be the interest you have shown in collecting information as to lightning effects; and the reiterated complaints of those who study the matter of the difficulty of getting such information untinctured with optical illusion effects, and so on. I could tell you of some wonderful things seen in shops, &c., lighted by us, on the occasion of this flash (which was most startling); but I did not notice anything of the kind, and rather doubt whether anyone who caught the full light of the flash could know for a minute after whether the lamps burnt blue or green; or, indeed, whether they were alight or out.

If these slight remarks are of any value, you will please put them to any use you see fit. H. M. Sayers.

ELECTRIC WELDING.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your editorial on "Welding by Electricity" in last week's number you say, "Strangely enough, though this fact has been known so long, it does not seem to have occurred to any single soul, until three years ago, that if for the two carbons there were substituted two pieces of metal, and an end pressure applied, the two metal rods would become welded together."

Permit me to inform you that I, and doubtless numerous other persons, saw electric welding done more than twenty years ago by a "Wilde" machine. I myself welded a tang upon a file with but slight blistering at the junction.

Mr. Wilde's patent, No. 1,412, of 1865, expressly mentions the application of his machine to welding, but he does not appear to have brought it into practical operation.—Yours, &c.,

17 and 18, Cornhill, E.C., April 26, 1890. F. Higgins.

THE DIATHERMANCY OF AIR IN RELATION TO THE EFFICIENCY OF INCANDESCENT LAMPS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your issue of the 18th inst. there is an abstract of a Paper read before the Institution of Electrical Engineers by Mr. Higgins on "The Diathermancy of Air in relation to the Efficiency of Incandescent Lamps." This contribution contains nothing new, nor do I see any additional reliable practical results therein, beyond what have been already published. The results Mr. Higgins has obtained with his three lamps, and by using a thermopile for his purpose, could have been obtained by a practised person using his bare hand for the test; and a person could have separated these three particular lamps according to their order of exhaustion.

I should be inclined to think that diffusion and convection have, in at least two of the cases, more to do with Mr. Higgins' results than diathermancy had.

In the same Paper he says, he has not seen or heard of any previous mention of this property as affecting incandescent lamps, &c. Diathermancy, *i.e.*, the permeability of the surrounding medium to radiant heat, is directly recognised when using the well-known hand test, and the varying effects on the efficiency of lamps caused by imperfect exhaustion have been long known to lamp-makers and used as a rough test of the state of exhaustion.

Mr. A. Bernstein published an article in the *Centralblatt für Electrotechnik*, and *Industries*, March, 1889, showing the energy per unit of surface required to maintain a dull red glow (526° C.) when using platina wires enclosed in a medium at various pressures, from 760mm. down to his best obtainable vacuum. Also, Mr. Swinburne, in his Papers on lamp manufacture, a year or two ago, in the *Electrical Review*, pointed out that the observation of excessive warmth was an indication of bad exhaustion.

The practical use of this property as a test of the minute differences in the vacua of carefully made glow lamps does not seem to hold out promise of any reliable results, and to me it seems not such a simple matter as Mr. Higgins would imply. For instance, the differences in the state of exhaustion between two carefully made lamps, which have been already tried by the coil test, are in any case far within the $\frac{1}{10}$th inch Mr. Higgins gives; and these differences are of such a fine order as to be immeasurable when compared with the differences likely to have arisen in the measuring, firstly, of the surfaces of the filament, and secondly, of the electrical power converted therein. The coil test can only by great care and exact observation of results be made fairly satisfactory; and one would therefore still wish for a test which would not want so many precautions, and would quickly show comparative states of exhaustion, not within $\frac{1}{10}$th inch, but $\frac{1}{10}$th millimetre at most. With the coil test, and however performed, lamps will give a negative result both with perfect vacuums and very imperfect ones; but such lamps, if mixed together, can be readily separated by incandescing them and using the hand-test.

Mr. Higgins also remarks that lamps with a perfect vacuum attain and lose their incandescence slowly when the current is applied or removed, while those lamps having an imperfect vacuum start suddenly into incandescence and as suddenly lose it. Although this may be quite true of similar metallic filaments, yet, on the other hand, with carbon filaments, both these effects may be simultaneously obtained by placing two carbon filaments in the same bulb, but one of which filaments varies somewhat from the other, either in specific resistance or condition of surface. By taking two such filaments, one having a high specific resistance and the other having a low specific resistance, and both having similar surfaces, giving the same candle-power and requiring the same number of watts per candle-power; then, by simultaneously applying and removing the current to these two filaments and when enclosed in the same medium, it will be seen that Mr. Higgins' statement has, at least, reservations, and has no practical signification; for the carbon of low specific resistance will slowly increase in incandescence and as slowly lose it, while the carbon of high specific resistance will suddenly increase in incandescence and as suddenly lose it.—Yours, &c., C. J. Robertson, A.I.E.E.

Middelburg, Holland, April 30, 1890.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

April 1, 1890.

5,054. C. Kellner. London. Improvements in the process of bleaching fibrous material by aid of electricity.

5,062. C. J. Van Depoele. London. Improvements in and relating to electric railways, and more especially to the overhead switches and overhead contacts.

5,067. P. Heskier. Copenhagen, Denmark. A device to be worn upon the person for obtaining voltaic effects.

5,069. C. W. Sleeman. London. Improvements in "step-by-step" instruments.

5,087. H. H. Lake. London. Improvements in electric conductors on cables (John Arnold Barrett, United States).

April 2, 1890.

5,135. R. Belfield. London. Improvements in cores for converters and for other electrical apparatus (partly communicated by the Westinghouse Electric Company, United States).

April 3, 1890.

5,191. W. Lucas and T. A. Garrett. London. Improvements in and connected with apparatus for detecting electrical radiations.

5,219. F. V. Andersen. Catford, Kent. Improvements in electric arc lamps.

5,228. W. P. Thompson. Liverpool. Improvements in galvanic elements (Louis Hoppe and Günther Hoppe, Germany).

April 5, 1890.

5,235. W. B. Sayers and J. Sayers. London. Improvements in electric generators and motors.

Digitized by Google

April 8, 1890.

5,335. H. H. LAKE. London. Improvements in machines for insulating electrical conductors (Charles T. Stetson, United States).

5,344. H. H. LAKE. London. Improvements in apparatus for measuring the strength and electromotive force of electric currents (M. M. Garver, United States).

SPECIFICATIONS PUBLISHED.

1889.

6,410. BURNELL (Wilms). Galvanic cells. (Price 8d.)

7,796. BENSON. Electric conductors. (Price 6d.)

8,030. UNGER. Charging electric accumulators, &c. (Price 6d.)

9,119. FIFORD. Electric bells, &c. (Price 6d.)

9,133. LAKE (Lacomb and Co.). Electric Lamps. (Price 6d.)

9,162. BROWN. Dynamo Machines. (Price 8d.)

9,304. BARNICOAT. Electrical switches. (Price 6d.)

1890.

1,878. WILLIAMS. Electric insulating compound. (Price 6d.)

2,986. WOLLEN and WERLINE. Electric lamp sockets, &c. (Price 8d.)

3,008. HOLLINGSHEAD and CARNEY. Storage batteries. (Price 6d.)

3,013. HARTMANN. Storage batteries. (Price 8d.)

3,484. SCHWEIZER. Electric secondary clockwork. (Price 6d.)

Amended Specifications.—1888.

9,171. LANGDON. Electric lighting of railway trains. (Price 11d.)

Second Editions.

742. GROTH. Tanning hides by electricity. (Price 8d.)

Third Editions.—1889.

3,988.** ANGLO-AMERICAN BRUSH ELECTRIC LIGHT CORPORATION (LTD.). Electric Lighting, &c. (Price 6d.)

1881.

783. PERRY and AYRTON. Electrical Conductors. (Price 11d.)

COMPANIES' MEETINGS & REPORTS.

Indo-European Telegraph Company (Limited).

The twenty-third ordinary general meeting of the members of this Company was held on Monday, at Winchester House, Old Broad-street, under the presidency of Mr. J. Herbert Tritton.

The MANAGING DIRECTOR (Mr. W. Andrews) read the notice convening the meeting, the seal was affixed to the register of shareholders, and the report of the Directors was taken as read.

The CHAIRMAN: I now beg to move—

"That the report and accounts now submitted be received and adopted, and that a dividend be and is hereby declared for the half-year ended December, 31, 1889, of 17s. 6d. per share, making, with the interim dividend already paid, 6 per cent. for the year, and a bonus of 20s. per share, both free of income tax, making in all 10 per cent. for the year."

In moving that resolution, gentlemen, you will permit me to draw the attention of the proprietors to the working of the Company in the past year. The results of the working, as you have already seen from the report, are much the same as for the previous year. The receipts are fractionally less, by the sum of £2,038. The expenditure on commercial account has been practically the same, with variations in the details; but when we come to maintenance account the expenditure has been materially more, and shows an increase of the considerable sum of £6,819. This, you will be pleased to hear, is attributable solely to additions and improvements on our line. In view of this expenditure we carried forward, as I daresay you remember, from 1888 to 1889 the sum of £6,783, and, if I remember right, we told you that that would in all probability be absorbed. The forecast made by our good friend Mr. Andrews was singularly accurate; for the additional expenditure during the year has been almost precisely that amount, as you will have noticed from the accounts. During the year now current we shall also have to face an extraordinary expenditure in maintenance account, though not at all of the same serious nature. The sum will depend very much on the amount of work which we can put through during the year. It is impossible to say how much the expenditure will be; but I think I may, without much fear of the event belying my word, say that it will not be an amount at all likely to affect any dividend which may be earned. We are still face to face with the fact that the decreased revenue from messages exchanged with India, to which I adverted at some length last year, goes on. This has followed upon the reduction of tariff which took effect upon July 1, 1886, since when the receipts from this source have shown a continuous decline of a serious character. I should like to put before you the statistics of the gross receipts of Indian messages for the last five years. In 1885 the amount was £394,270; in 1886, the year when the reduction of tariff was made, the amount was £374,122; in 1887 it was £342,272; in 1888 it was £334,129; and in 1889 it was £328,490. I think I am not wrong in saying that that decrease is of a serious nature. The result is the more extraordinary because the imports and exports of India have not shown, I am pleased to say, the same unsatisfactory figure. The *Journal* of the London Chamber of Commerce, which I may remark is a very useful and interesting publication, gives the imports and exports of India for the year 1885-86 as £154,850,000, and for the year 1888-89 as £163,500,000—an increase of £8,650,000—not large, perhaps, but still an increase; and if we turn to the shipping tons engaged in the same trade a similar increase is shown. In 1885-86 the number of these tons was 6,654,000, and in 1888-89 the number was 6,983,332. We are, therefore, driven to look for an explanation elsewhere than in the trade itself. These contradictory results show two or three things, I believe—first, that decreased cost does not stimulate the demand in the case of long-distance telegrams; second, that the systematised use of codes, and possibly also that of registered addresses, has attained greater proportions; and, third, that the average of all the items which make up the external trade of India, so far as they have been affected by telegrams, must have been larger. I fear we can hardly think that we have yet touched bottom in this matter. It is one of the subjects which the International Conference, which is shortly to meet in Paris, has before it, and with which, I imagine, it will endeavour to deal. Private messages in plain language really hardly affect our business. It may be almost difficult to believe, but it is a fact that, under ordinary circumstances, these private messages in plain language do not amount to 1½ per cent. of the business passing over our lines—a most remarkable fact. You will judge, therefore, how very deeply interested we are in the coding and packing systems in the present day. Our business is to cultivate trade messages with our mercantile friends who use our lines, and I need hardly remind you that it is their business to make a given expenditure in telegrams go as far as possible—to cut down, in short, their ordinary expenses to as low a degree as possible, and to attain the greatest gain at the smallest cost. That is what we all come to the City of London for, I imagine. As I have said, the International Telegraph Conference is going to meet very shortly in Paris, at which this Company will be represented by Mr. Andrews, assisted by Mr. Moll. The losses made by low rates are now so large, and the accumulated losses so considerable, that it is to be hoped taxpayers will not be further amerced to contribute still more towards the cost of international messages sent by merchants for purposes of profit, and by wealthy travellers and others for purposes of luxury and convenience. I do not know that there are any other matters in the singularly uneventful history of the past year to which I need advert; but I would not like to sit down without expressing on behalf of the proprietors, whether shareholders or Directors, the high sense we entertain of the very efficient way in which the work of the Company is performed by the staff, from the highest to the lowest. Much of it is necessarily of a very monotonous and trying character, but it is admirably done both at home and abroad. Mr. Andrews, our esteemed Managing Director, is second to none in business capacity, and his example animates and regulates the whole work of the Company in a very remarkable way. I have now the pleasure of proposing the resolution which I have read.

Major-General G. B. TREMENHEERE, R.E., seconded the motion.

Mr. JACKSON said he thought that the Chairman, referring to the difficulties under which they laboured in connection with increasing the revenue of the Company, had "spotted" a common objection among telegraph companies when he said that private messages brought such a small amount of income. He (the speaker) did not know how this was to be remedied, but he thought it might be affected in connection with their representative at the forthcoming International Telegraph Conference at Paris by their able general manager. In the case of the Anglo-American Telegraph Company he had been assured by one of the Directors, the Marquis of Tweeddale, that a cablegram could be sent at the nominal price of 1s. a word, and that it might really cover 20 or even 24 words. He thought that this was a point that should be brought by their manager before the Conference as an illustration of the comparative unfairness of a so-called nominal tariff; and in considering this question he thought that some modification in reference to code messages should, if possible, be adopted. In face of the fact that their revenue was decreasing to a certain extent, he thought the shareholders must not expect the present handsome dividend was going to last for ever. Their concession would terminate in fourteen years. Their reserve fund was sufficient to meet all possible contingencies, and every arrangement had been made for the depreciation of the plant, which he believed was now in the most efficient condition. He thought it would only be a prudent step to make some arrangement for returning a part of the capital, and if that were done to the extent only of £1 a share, their position would be strengthened when the concession terminated, as their capital would be so small that no one, however anxious to compete, would be able to enter into the competition with them.

The CHAIRMAN: Are there any further observations or questions? Receiving no reply he continued: Mr. Jackson has made a forcible plea, not for the first time, to the Directors to consider the subject of dealing with the reserve fund within a period not so remote as the termination of our concession, as I understand him. The matter has been considered by the Board from time to time. We are in favour, I may say personally and individually, of strong reserves for all purposes, and for a great many reasons, partly connected with the terminability of the concession, and partly for reasons which have a very wide basis of uncertainty. Of course, it might suit some of our shareholders to receive back a portion of the amount of this fund by way of return and reduction of capital; but I can conceive that there are other shareholders who might take a very different view of the question, and who might prefer to see it kept in reserve until the future is much clearer than it is at present. I must not go further than to say that the subject shall continue to have our best consideration. We are all anxious to improve the line, and to extend its earning powers as far as possible, and if we could see our way to utilise a portion of our reserve fund in one or other of those ways it might be a very legitimate thing for us—speaking individually, and without consulting with my colleagues—to take into consideration. Speaking again individually, I should

Digitized by Google

be very sorry to see any repayment of capital carried into effect at present. I think the risks of the future warrant our keeping this large amount in hand and increasing it; but it might be different in the course of time, and then we shall see whether the shareholders are really of opinion that they would wish to have the money in their pockets rather than in the coffers of the Company. He then put the resolution in the usual manner, and declared it carried unanimously. Continuing, he proposed the re-election of the retiring Directors, Mr. C. Holland and Mr. H. H. Meier.

Mr. C. W. EARLE seconded the motion, which was carried unanimously; and the auditors, Messrs. C. F. Kemp, Ford and Co. were afterwards re-appointed.

Mr. JACKSON then proposed and Mr. STEVENS seconded, a vote of thanks to the Chairman, Directors, and staff; and the resolution was carried unanimously.

The CHAIRMAN: On behalf of the Directors and staff of the Company I beg to thank you for this renewed expression of your confidence and approval.

The proceedings then terminated.

Great Northern Telegraph Company of Copenhagen.

The following is an abridged report of the proceedings at the general meeting held at Copenhagen on April 26th, 1890; F. Zahle, Esq., in the chair.

The CHAIRMAN of the Company, C. F. Tietgen, Esq., in accounting for the working during the year 1889, first referred to—

The State of the Company's Cables, which, unfortunately, had left much to be desired during that period, particularly in Europe, where the cases of interruptions had numbered 19. Of this number 15 had fallen upon the three cables in the southerly section of the North Sea, the most southerly cable being that which connects France with Denmark, whilst the two others connect England with Denmark and Sweden. Nearly all these breakages had been caused by the trawl-fishing apparatus, which is still allowed to damage the cables with impunity, as the international legislation for the protection of submarine cables had not yet been extended to a control of fishing appliances. This regrettable fact had already been mentioned at the Conference held in 1883. The effects of the circumstances referred to, in addition to the constantly increasing traffic, would render it necessary for the Company to lay two new cables in the North Sea, one between France and Denmark, in order to duplicate the Calais-Faroe Cable, the only one of the Company's cables which had not yet been duplicated; and the other between England and Sweden, in order to ensure the transmission of the traffic between England and the north of Europe in the most efficient manner. Preliminary negotiations with regard to this subject had already been progressing, and the Company would do its best to accelerate the realization of its projects, more particularly as, during the early part of the year 1890, frequent interruptions had also occurred. In the far East the interruptions of the cables had been less frequent, the number having amounted to seven, none of which had interfered sensibly with the regular transmission of the traffic. In Europe, the Company's cable steamer, the "H. C. Örsted," had been in activity for 165 days during the year, and in the far East the "Store Nordiske" had been altogether on active service for 171 days.

The Working of the Lines had throughout been very satisfactory. Thanks to the efforts of the Russian Telegraph Administration, and to the introduction into Siberia of the Wheatstone system, the traffic between Europe and the far East, transmitted by the Wladiwostock route, had been carried with a regularity, speed and correctness which had left little to be desired.

The Traffic Revenue had reached about the same amount as the Company earned in the good years of 1884 and 1885, before the tariff reductions introduced at the Conference of Berlin came into force.

The Company's Position in China had not changed since last year's meeting. At the invitation of the Russian and Chinese authorities, the Company had, during two months last autumn, discussed the modifications desired to be introduced into the projected convention, which was signed at Chefoo in 1887; but notwithstanding the fact that the Company had acquiesced in all the demands of the said authorities, new obstacles to the final conclusion of the affair had arisen. They did not yet know the nature of those obstacles, for which reason they would prefer not to formulate any opinion as to the chances of arriving at a satisfactory solution.

The Company's Property.—The Company had acquired, in Copenhagen, a building site, situate at No. 26, Kongens Nytorv, and adjoining their present offices, for the purpose of erecting a building where the administration, as well as the mechanical workshops of the Company, could be located in a more practical manner than at the present, and notably less subject to the danger of fire. This measure had become a necessity on account of the development of the administration and the large increase of the archives during the progress made by the Company in the course of the last 20 years they had been in existence. The building operations had already commenced, and it would thus be explained that a somewhat larger amount than usual had been carried forward, in order to meet the current expenses under this head.

The Reserve Fund.—A rather larger amount than usual had been withdrawn from this fund, in order to defray the expense of 100 nautical miles of spare cable, to be employed in strengthening the cables in Europe. The laying of the two new projected cables already referred to would absorb, in the current year, another important amount from the reserve fund; probably, including everything, not far from £200,000. It would, therefore, have been imprudent to add less to the fund than the same amount as in previous years, the more so as they were on the eve of

An International Telegraph Conference, the decisions of which might possibly affect the revenue of the Company, as had happened before at the Telegraph Conference held at Berlin in 1885. This time the Conference would be held in Paris and would be opened on the 15th May next. All the administrations of the different States, as well as the representatives of the private telegraph companies, had been invited to take part therein. On the occasion the Company would, as usual, be represented by the managing director.

The report and balance-sheet (which appeared in our last issue) were then unanimously adopted.

The retiring Directors, C. F. Tietgen, Esq., and Capt. E. Suenson, D.R.N., were re-elected; and A. Berner, Esq., and S. Bille, Esq., were re-elected as auditors.

Five shillings per £10 share, representing the final dividend for 1889, are now payable at the Company's bankers, Messrs. C. I. Hambro and Son, No. 70, Old Broad-street, London, E.C., against Coupon No. 18.

Telephone Company of Ireland (Limited).

The eleventh ordinary general meeting of the proprietors of this Company was held at their offices, Commercial Buildings, on April 26th; Alderman Dillon, Chairman of the Company, presiding.

The SECRETARY having read the Directors' report,

The CHAIRMAN moved that the report be adopted. He said that was the first occasion on which he had to meet the shareholders in that position, although he had been with them in another position, since the inauguration of the Company. It was a source of deep regret to him that he should occupy that position in succession to two very warm friends of his—one of them one of his greatest friends, the late Mr. Gray, the first Chairman of the Company, with whom, as solicitor, he had the honour to be associated in introducing the telephone system in Ireland. They regretted also the death of Alderman Winstanley, who addressed them as Chairman at the last meeting of the Company. The Company were now to be congratulated on their progress. Since they last met an exchange had been opened in Cork, and the results there had been extremely satisfactory. From having at the commencement of the year 1889 24 subscribers to the Cork Exchange, they had on the last day of the year 295 subscribers. Their position in Cork had been somewhat peculiar. The Government or Post Office department had the control of the telephone service in Cork up to this year. That Company entered into competition with them during the year, with the result, he was glad to say, that the Government were practically beaten out of the field; and the Company had now the control of the telephone service in Cork, with subscribers to the number of nearly three hundred, although the Government, in the year that they had it, reached only a maximum of 30 subscribers. Belfast was out of their control. It was now worked by the Company with which they were associated, the National Telephone Company; but they had made arrangements with that Company for the construction of a trunk line between Dublin and Belfast, and they hoped the work would very speedily be in hand. Their development of the system in Cork had led to the result that their earnings could not be taken as representing what their future earnings would be, because they had not yet reached the advantages which would accrue to them from their expenditure in Cork. But their earnings generally had increased considerably during the past year, and now they had to divide a net earning of £8,900, as against £7,870 in the previous year. Their expenditure, both in Cork and in another direction, had been considerable. In Dublin they had replaced within the year, at a very large expense, nearly all the old iron wires, which, at the time they were laid, were considered the proper kind, by new copper wires, the life of which was very much longer indeed than that of the old iron wires. To meet this increased expenditure, but principally for the development of the trunk line to Belfast, they issued to their shareholders additional preference capital. They tried the experiment of issuing it at 5 per cent. to their Preference shareholders. He was afraid that they rather spoiled them by issuing the shares previously at 6 per cent. The result was that their shareholders did not appreciate, as they thought they ought to have done, the investment at 5 per cent., and did not take sufficient of the shares. They were, therefore, obliged to issue them now in the shape of Debentures. On this subject a special resolution would be proposed. The report also dealt with a formal matter, namely, their relations with the National Telephone Company, in consequence of which some alterations in their Articles of Association had become necessary. He had to apologise for the non-attendance of some of the Directors, with whom that happened to be a specially busy time, and who were, therefore, abliged to be absent.

Mr. ARTHUR DUDGEON seconded the motion, which was unanimously agreed to.

The CHAIRMAN moved the following resolution:—

RESOLVED:—"*That the Directors be, and they are hereby, authorised to borrow any sum or sums of money, on such security and terms, as to interest or otherwise, as they may deem fit, and may secure the same by mortgage or by other debentures, or by bonds, or by any mortgage or charge of or upon the whole or any part of any property, funds, assets, or effects of the Company, including uncalled capital, but so that not more than £35,000 be owing at any time, and that not more than £10,000 be issued without the previous consent of a general meeting.*"

Mr. ARTHUR DUDGEON seconded the above, which was unanimously carried.

The CHAIRMAN moved that the retiring Directors, Alderman V. B. Dillon and Mr. Hermann G. Erichson, be re-elected, which was seconded by Mr. ARTHUR DUDGEON, and agreed to.

Mr. WM. ANDERSON moved that Mr. John M'Kean be appointed auditor for the year ending 31st December, 1890, and that the joint remu-

Digitized by Google

neration of the auditors appointed by that Company and the United Telephone Company in liquidation be fixed at 50 guineas per annum.

Mr. EVANS seconded the motion, which was passed unanimously.

The CHAIRMAN said it was thought advisable a year ago that the great telephone companies in England should be amalgamated under one control. It was also proposed to do that by the United Telephone Company, which was the parent company, absorbing the other companies. Difficulties, however, having arisen with the Post Office it was decided to accomplish the end in view by the United Telephone Company being dissolved and formally liquidated, and its business being absorbed by the National Telephone Company, which also took over the Lancashire and Cheshire Telephone Company. The result was that the greater part of the services in England and the service in Ireland for the province of Ulster were effected by the National Telephone Company. Under the circumstances it became necessary, in order to give legal effect to the agreement which the Telephone Company of Ireland originally made with the United Telephone Company, and to transfer its obligations and concessions to the National Telephone Company, to pass a resolution making certain slight alterations in the Articles of Association of the Telephone Company of Ireland.

The CHAIRMAN read and moved these resolutions, which were of a formal character; and they were seconded by Mr. WILLIAM DUDGEON, and unanimously adopted.

Mr. WILLIAM DUDGEON moved and Mr. WILLIAM ANDERSON seconded a vote of thanks to the Chairman, which, having been passed, the proceedings terminated.

The Oriental Telephone Company (Limited).

The tenth ordinary annual general meeting of this Company was held on Tuesday, the 29th April, at the City Terminus Hotel, Cannon-street; Mr. W. Addison presiding.

The SECRETARY (Mr. Alex. B. Chalmers) read the notice convening the meeting, and the report of the Directors and statement of accounts were taken as read.

The CHAIRMAN said: Gentlemen, before moving the adoption of the report and balance-sheet I have very little to add to the information therein. I think you will all allow our figures and our statements are as plain as could be wished, and, therefore, render unnecessary any long speech from me. I am glad to tell you that your Company is making steady progress, and that it is gradually strengthening its financial position. In 1884 the reserve fund, which had for the previous two years stood at £7,000, was, in order to meet the exigencies of the financial position at that time, transferred to the credit of profit and loss, and, since then, until last year, no reserve fund has existed. Your Directors, however, felt that as soon as they were in a position to do so, a new reserve fund should be formed in order that in case of need there might be a fund to fall back upon other than the uncalled capital of the Company; and in pursuance of that purpose, we placed £2,500 to reserve last year, and this year we add another £2,000. This, I am sure all will acknowledge, must add to the financial strength of your Company. Our reserve now stands at £4,500, as against £7,000 at the beginning of 1884. I will just add that the present fund is easily realisable, and indeed could be immediately used on an emergency. You will see that we have written off £500 for depreciation of stores at branches, principally at Mauritius; and we do this in order that that particular asset in our balance sheet should be fully of the value we assign to it. We carry forward this year about £550 more than we did last year; but we may, if business in the East improves, and the demand for telephonic communication increases, require a larger amount in hand than hitherto, in order that the business should not suffer for want of funds. The Directors have arranged that the balance to the credit of their current account at the bank should not exceed a certain amount, and all sums not invested beyond that should be placed on deposit, so that the Company may have the benefit of the interest. The change that has been made at Mauritius by the appointment of a Manager thoroughly acquainted with French, is likely, I think, to result in distinct advantage to us, and we hope now that that which has hitherto been a profitless exchange may help to augment our revenue. In China the business is steadily improving, and I confidently look forward to the China and Japan Company participating to a still greater extent in the general prosperity and progress which is showing itself in that hitherto very conservative country. You will see that we have not been unmindful of our promise to endeavour to come to an arrangement with the holders of the vendors' shares, but up to the present we have not succeeded. We called a meeting of those shareholders, but nothing definite was done. Your Directors think it would be most beneficial to the Company generally if both classes of shares were assimilated, and that there was only one interest instead of two conflicting ones; and we are perfectly prepared to carefully consider any suggestion for arrangement which may come from the vendors' shareholders. I have nothing further to add, and therefore beg formally to move the adoption of the report and balance-sheet. When this is seconded, I shall be glad to answer any questions which shareholders may wish to ask. I beg to move:

"*That the Directors' report, together with the balance-sheet to December 31, 1889, be approved and adopted, and that a dividend at the rate of 3 per cent., free of income-tax, for the year ended December 31, 1889, be declared on the paid-up capital of the Company other than the vendors' shares.*"

Mr. THOMAS LLOYD seconded the resolution, which was agreed to unanimously without discussion.

On the motion of Mr. B. ST. JOHN ACKERS, seconded by Mr. LLOYD, Mr. Addison was unanimously re-elected to his seat at the Board, as also was Mr. G. B. Frost, on the motion of Mr. HENRY GREWING, seconded by Mr. LLOYD.

Mr. PELL then proposed, and Mr. GIBBS seconded, the re-appointment of the auditors, Messrs. Deloitte, Devers, Griffiths, and Co., which was agreed to; and, the Chairman having been thanked for presiding, the proceedings terminated.

China and Japan Telephone Company (Limited).

The seventh ordinary general meeting of the shareholders of this Company was held at the offices, Austinfriars, yesterday (Thursday).

Mr. T. Lloyd was voted to the chair, on the motion of Mr. H. GREWING, in the absence of the Chairman of the Company, Mr. H. G. Erichsen, who telegraphed stating that he was unable to be present.

The SECRETARY (Mr. A. B. Chalmers) read the notice calling the meeting, and the report of the Directors was taken as read.

The CHAIRMAN: I do not think it is necessary to make any lengthy statement. I have much pleasure in saying that our business is fairly progressing. We are not making any very rapid advance; but the progress seems very satisfactory. You see we are able to carry forward a large balance, and are able to write off more for depreciation, and the Hong Kong exchange is now nearly self-supporting. I beg to move:—

"*That the Directors' report and the audited accounts for the year ended December 31, 1889, be, and the same are hereby, received and adopted.*"

Mr. GREWING seconded the motion.

Mr. A. LITTLE said that in 1882 he sold out the plant that he had purchased at Shanghai, and the goodwill, such as it was, for 937 fully paid-up shares = £937. The transaction was settled by telegraph, and he did not know that other vendors were receiving £17,000. That sum, which, he believed, was largely in excess of the value of the plant, must, of course, have been for goodwill, and he doubted very much whether the goodwill was worth anything like the sum paid for it. They had now been eight years without receiving any dividend, and it occurred to him whether it would not be a good thing not to keep the capital at an amount which it appeared to him they were never likely to receive any respectable dividend upon, and to write it down to the actual value of the plant at Shanghai and Hong Kong. It seemed to him that as long as they had a capital of £20,000, of which £14,761 was issued and £4,500 of debentures on which they paid 7 per cent., the prospect of the shareholders getting a dividend was very small. The Directors themselves absorbed very nearly half the surplus of 1888. He thought his suggestion worthy of consideration, and believed that if it could be adopted they would be on a better footing. So far as he was concerned, he would prefer to hold £400 of dividend-paying shares than £930 of nominal capital with no dividend. They would stand in a better position in China if they were known as a dividend-paying Company.

The CHAIRMAN: With respect to Mr. Little's suggestion, I can only say that the Directors will be very pleased to take it into consideration. Of course, it is not a matter that could be settled off-hand. In fact, no Director would be justified in giving an opinion without consulting with the Board. But, apart from the Board, there is one shareholder whose holding is larger than that of any one else, and that one shareholder could practically decide the matter. The suggestion will be put before the shareholder by a gentleman who is present, and who has heard what Mr. Little has said. All I can say, speaking for the Board, is, that we will take it into consideration, and we shall have it brought before the gentleman I have referred to, so that it will receive full consideration. He then put the resolution in the usual manner, and it was carried unanimously. Continuing, he proposed the re-election of Mr. Grëwing.

Mr. G. B. FROST seconded the motion, and stated that, as the representative of the Oriental Telephone Company, he would take care that Mr. Little's suggestion was placed before the Board of that Company and duly considered.

The motion was carried unanimously.

Mr. FROST proposed, "That 200 guineas be voted to the Directors for their services last year." He knew perfectly well, he said, that the Directors were doing their best and working hard to make the undertaking a paying concern, and he hoped before long that they would not only see the interest upon the Debentures paid, as had hitherto been done, but that they would also have a substantial dividend for the shareholders.

Mr. M'LEOD seconded the motion, which was carried *nem. con.*

The CHAIRMAN: I may remark, in reply to what Mr. Frost has said, that the prospects in Hong Kong are very good. As I said just now, the exchange there is nearly self-supporting. I do not wish to say more, but I think the outlook there is improving, and I hope by-and-by it will do much more than pay its way. Our advices are encouraging, certainly.

On the motion of Mr. LLOYD, seconded by Mr. FROST, Messrs. Price, Waterhouse, and Co. were re-elected auditors; and the proceedings terminated.

The following is the report of the Directors referred to by the Chairman:—

The revenue account for the year 1889, after charging debenture interest and writing off a sum of £100. 15s. 10d. in respect of depreciation of plant, &c., shows a balance of £741 to credit, which has been transferred to profit and loss account. Including the sum of £32. 16s. 4d. brought forward from last year, this account shows an amount of £773. 16s. 4d. to credit, which the Directors propose to carry forward after writing off £200 in final extinction of preliminary expenses account. At both Shanghai and Hong Kong the increase of revenue during the year has been fairly satisfactory, and the exchange at the latter place is now nearly self-supporting. As foreshadowed in a previous report, the competition in sales of material has increased, resulting in a diminution of profit from this source. In order to provide additional working capital, the Directors have issued during the present year a further £500 of debentures, bearing interest at 7 per cent. These were taken up by the Oriental Telephone

Digitized by Google

Company (Limited). The Director who retires at the present meeting is Mr. Henry Grëwing, who offers himself for re-election. Messrs. Price, Waterhouse, and Co., the auditors, also retire, and offer themselves for re-election.

The Brighton and Hove Electric Light Company.

The annual general meeting of this Company was held at the Company's offices, 47, Gloucester-road, Brighton, on the 25th ult. In the absence of Mr. Robert Hammond, the Chairman of the Company, Mr. Latham occupied the chair.

The CHAIRMAN much regretted that the Company was unable to declare a dividend, but said it would be found that the accounts were far from being unsatisfactory; and the Company might congratulate themselves upon the steady increase of their business, which, but for reasons stated in the report, would have yielded a dividend as great or even greater than that declared in past years. The reasons why no dividend was declared were (1) The reduction in the price, which was decided upon in order to give the customers the advantage of the best possible terms. (2) The running of the machinery during the day, which was arranged for the convenience of those customers who desired to use the light during the dark and foggy days, or in places where artificial lighting by day was a necessity. Unfortunately, this could not be continued, in consequence of the Board of Trade having decided that it would not be advisable to run the risk of workmen touching the wires while engaged on the roofs of houses. (3) The great advance in the price of coal, which is well known. It was to be regretted that the Company had been unable to distribute as dividend the 3½ per cent. profit made during the year, in consequence of a law suit, Garman v. the Company, having gone against them, a workman having met with an accident on the roof of one of the breweries of the town, and it was supposed that he received a shock from one of the wires which passed over the brewery. The jury delivered a verdict against the Company, and assessed damages to the amount of £800. The Company, however, is appealing against these damages, and awaits the result. Referring to the action of the Corporation the Chairman said the Directors felt that the Corporation had treated the Company most unfairly, but their experience assured them that it would be impossible to supply electricity at the present time for less than 10d. per unit unless the supply was much larger than can be expected at present, leaving out the fact that the Company was working the most economical system known. This was proved beyond all doubt by the experience of Chelmsford, where one of the Brighton Corporation's electrical advisers, Mr. Crompton, definitely said that he cannot supply at less than 1s. 4d. per unit, and this on the low-tension system adopted by the Brighton Corporation. The Company had again applied to the Board of Trade for a Provisional Order, and trusted that notwithstanding the fact that the Brighton Corporation had hitherto refused to consider any advances towards compromise on their part, some arrangement would ultimately be made. It should be borne in mind that the Company could still continue their supply by means of overhead mains, under the regulations of the Board of Trade, whatever happened; and that although they might possibly lose part of their business to the Corporation they could easily fill up their vacancies with consumers outside the Corporation's area of supply. The shareholders might be congratulated upon the election of Mr. F. W. Bentley and Mr. Arthur Kimber as Directors, the latter representing the Company's consumers and the ratepayers of the town, he being connected with several of the largest hotels in Brighton, who obtained their supply from the Company. The Chairman concluded by proposing that the report and accounts for the year ended December 31, 1889, be received and adopted.

The motion was seconded by Mr. CASH, and carried.

The retiring Directors, Mr. Robert Hammond and Mr. P. A. Latham, were re-elected.

After a cordial vote of thanks to the Chairman and Directors, the proceedings terminated.

Brazilian Submarine Telegraph Company (Limited).

Report of the Directors and the accounts for the half-year ended December 31, 1889, to be submitted to the thirty-third ordinary general meeting, to be held at the offices, Winchester House, Old Broad-street, London, E.C., on Wednesday, May 7, 1890.

The Directors submit the annexed accounts and balance-sheet for the half-year ended December 31, 1889.

The revenue for this period amounted to £121,119. 5s. 11d., and the working expenses to £15,201. 14s. 2d. After providing £12,880 for debenture interest and sinking funds, and £1,671. 14s 10d. for income-tax, there remains a balance of £91.365. 16s. 11d.; to this is added £2,609. 3s. 9d. brought forward from June 30th last, making a total of £93,975. 0s. 8d. First and second interim dividends amounting to £39,000 have been paid, and £45.000 transferred to the reserve fund, leaving the sum of £9,975. 0s. 8d. to be carried to the next account.

In accordance with the provisions for repayment of the first issue of Debentures, dated July 31, 1884, 153 bonds representing £15,300 were drawn on April 25th for payment at par on July 31st next. This, with the previous drawings, will make a total repayment of £80,800, leaving £69,200 of the first issue of Debentures outstanding.

The working expenses of the stations are £1,630 in excess of those for the previous half-year; the increased expenditure is principally due to the extension of the Company's staff quarters at St. Vincent, the furnishing thereof and the augmented staff rendered necessary by the South African traffic exchanged at St. Vincent with the cables laid to the Cape of Good Hope.

The various sections of the Company's line are in good working order.

West India and Panama Telegraph Company (Limited).

Report of the Directors and the accounts for the half-year ended December 31, 1889, to be submitted to the twenty-sixth ordinary general meeting, to be held in Room 174, Winchester House, Old Broad-street, London, E.C., on Wednesday, May 7, 1890.

The Directors submit the accounts for the six months ended December 31, 1889. The amount to credit of revenue is £42,768. 0s. 1d. (against £43,061. 16s. 9d. for the corresponding half-year of 1888), and the expenses have been £27,071. 7s. 0d. (against £21,425. 1s. 2d. for the same period in 1888), leaving a balance of £15,696. 13s. 1d., which, with the balance of £1,609. 2s. 1d., brought from last account, makes a total of £17,305. 15s. 2d., with which it is proposed to deal as follows:—

First Preference Shares—			
Dividend, 6 months to 31st December, 1889, 6s. per share	£10,368	18	0
Second Preference Shares—			
On account of arrears of dividend to 31st December, 1889, 27s. 6d. per share	6,419	17	6
Balance to current half-year's account	516	19	8
	£17,305	15	2

The traffic receipts for the six months show a decrease of £594. 12s. 7d., as compared with the corresponding period of 1888.

The large increase of £5.718. 15s. 1d. in the cost of repairing cables is accounted for by the number of interruptions having been in excess of the average, and by the expenditure of greater lengths of new cable to renew and strengthen the system in those parts where weakness or decay were proved to exist.

In a previous report the shareholders were informed that a new line of cables connecting Santiago-de-Cuba (our terminal station) with Hayti, San Domingo, Curaçoa, and Venezuela had been laid and opened for traffic by a French company, and at the three last half-yearly meetings the Chairman has referred to the possible extension of the French company's operations within this Company's system. The Directors have now to report that the French Government, in furtherance of its policy to encourage independent telegraphic enterprise by its own subjects, has entered into a convention with this new company for connecting Martinique and Guadeloupe, with a view to an eventual extension to the United States and Europe by a French line of cables; and that in pursuance of this convention, a cable (about 100 miles in length) was laid between Martinique and Guadeloupe and opened for traffic in February last, thus competing with this Company's cables between those islands. At the instance of the French Colonial Minister the annual subsidy of £2,000 hitherto paid by Martinique to this Company is held to be withdrawn by the Council General of that island, and a like subsidy has been granted to the competing company, notwithstanding that such subsidy was previously renewed to this Company up to December 31, 1890. To this manifestly unjust proceeding the Directors will offer such objections as they may be advised are open to them. Martinique and Guadeloupe are, however, still dependent on this Company's duplicated cables, comprising some 4,000 miles, for their telegraphic communications with the rest of the world, and for their daily bulletins of news and market prices, which cost this Company a large sum to collect and transmit, although the subsidy is transferred to an undertaking performing none of these obligations, and connecting these two colonies by an isolated length of only 100 miles of single cable.

In accordance with the Articles of Association, Sir James Anderson, and William Andrews, Esq., retire at this meeting, and offer themselves for re-election.

John George Griffiths, Esq., the auditor, also retires, and offers himself for re-election.

Western and Brazilian Telegraph Company (Limited).

Report of the Directors for the half-year ended December 31, 1889, to be presented at the nineteenth ordinary general meeting of the Company, to be held at Winchester House, 50, Old Broad-street, London, E.C., on Friday, May 9th, at 12 noon.

The total earnings amount to £86,403. 0s. 7d., as against £112,250. 6s. 11d. showing a decrease of £25,847. 6s. 4d. compared with the half-year to December 31st, 1888. It will be observed that this decrease is much less than could have been expected when the shareholders met in November last; this is mainly owing to the greatly increased take during the last two months of the year, viz., November and December.

The working expenses amount to £40,391. 11s. 9d., as against £31,220. 4s. 2d., an increase of £9,171. 7s. 7d.

Including the amount brought forward from June 30, 1889 (£4,072 9s. 8d.) and the dividend received upon the shares held in the "Platino" Company, the balance to the credit of the revenue account is £57,462. 18s. 6d., from which has been deducted £13,500 for debenture interest, £7,500 for the renewal fund, and £5,600 for the debenture redemption fund. This leaves £30,862. 18s. 6d. The Directors now recommend the payment of a dividend of 6s. per share, free of income-tax, on the ordinary shares for the half-year, making, with the dividend paid in November, £4 per cent. for the year, leaving a balance of £3,248. 16s. 6d. to be carried forward.

Under Abstracts A and C, "expenses at stations and in London," the outlay is practically the same as for the corresponding period, which is a satisfactory feature considering the additional work done. In fact, out of the increased expenditure of £9,171. 7s. 7d., £7,281. 9s. 7d. is attributable

Digitized by Google

to the necessity of chartering a cable steamer to fill the place of the "Norseman," called home for repairs; this was of course imperatively necessary for the protection of the revenues, and has already been approved by the shareholders. Of the remaining increase £928. 14s. 11d. is for additional cable used in repairs; £78. 15s. for auditors' fees, and £809. 11s. 1d. for increased amounts set aside for depreciation of Company's ships. It will be remembered that the strikes at Leith delayed the repairs to the Company's steamship "Norseman," which increased the amount payable under charter. The "Norseman" returned to her station last November and the "Buccaneer" was immediately discharged.

In the case of shares which have been divided into Preferred and Deferred, 1s. 6d. per share of the dividend now recommended will be payable to the Preferred shareholders, and 4s. 6d. per share to the Deferred shareholders.

The first annual drawing of the "A" and "B" Debentures took place at the Company's offices on January 24th last, in the presence of Mr. W. W. Venn, jun., notary, when Debentures amounting to £11,200 were drawn, and have since been paid off at par.

The shareholders are aware that since the last meeting great changes have taken place in the Government of Brazil. With a view to further the shareholders' interests, the full report of the meeting of the shareholders in November last, containing the Chairman's speech and observations of the proprietors, together with a synopsis of the Company's case, were submitted to Her Majesty's Secretary of State for Foreign Affairs, with request that the influence of the British Minister in Rio de Janeiro might be brought to bear thereon. These documents appear to have convinced the Government here that the Company's case was entitled to favourable consideration; and the Foreign Office accordingly instructed Her Majesty's Minister in Rio de Janeiro to use his friendly influence on the Company's behalf, and the thanks of the Company are due to Lord Salisbury for the support thus afforded to British enterprise. The matter is still before the authorities in Brazil, and everything has been done that can be done to bring about a favourable reply.

The dividend warrants will be posted on May 15, 1890.

The International Telegraph Conference will meet at Paris in May next. The Company will be represented, as heretofore, by the managing director.

The retiring Directors are Mr. C. W. Earle and Mr. Henry Weaver, who offer themselves for re-election.

The auditors, Mr. John Weise and Mr. John G. Griffiths, retire, and are eligible for re-election.

The Anglo-Portuguese Telephone Company (Limited).

The following annual report of the Directors of this Company will be presented at the adjourned third ordinary general meeting of the Company, to be held at the offices of the Company, 53, New Broad-street, E.C., on Thursday, the 8th inst., at three o'clock:—

The profit on the year's working amounts to £5,361. 16s. 8d. After deducting £600 paid for Debenture interest, and adding £5,827. 19s. 7d. brought forward from 1888, there remains a balance of £10,589. 16s. 3d. to the credit of profit and loss account. Out of this an interim dividend of 4 per cent. has been paid, and it is now proposed to write off the £1,500 discount on Debentures issued, and to place £6,000 to a reserve fund, leaving a balance of £1,089. 16s. 3d. to be carried forward to this year's accounts. The expenditure on capital account for the year amounted to £9,731. 13s. 10d.

The number of paying subscribers at 31st December last was—

In Lisbon,	985, of a gross annual value of	£7,180
„ Oporto,	870, „ „ „	4,708
		£11,888

showing a total increase in subscribers of 222, and in value of £1,320 over the preceding year.

In order to provide for further extensions, £40,000 Eight per Cent. Second Mortgage Debentures have been created, of which £10,000 were recently offered to the shareholders of the Company in Portugal for subscription. The Directors regret to announce the retirement of the Conde De Gouvea from the Lisbon Board, and of the Company's legal adviser in Portugal, Dr. Marcal Pacheco. Mr. Arthur Henry Baker, of the London Board, and Senhor Jorge O'Neill O'Neill, of the Lisbon Board, are the retiring Directors at the forthcoming general meeting, and being eligible offer themselves for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths, and Co., being eligible, offer themselves for re-election.

House-to-House Electric Light Supply Company (Limited).

The following is the report of the Directors to be presented at the second ordinary general meeting to be held at the Central Electric Lighting Station, Richmond-road, West Brompton, on Monday, May 5, 1890:—

In submitting to the shareholders the report of the operations of the Company to December 31, 1889, the Directors have pleasure in reporting the satisfactory progress of the business of the Company.

The total number of shares issued is 8,322 ordinary shares of £5 each, and 100 founders' shares of £5; and in order to meet the further requirements of the Company, the Directors have issued £30,000 Debentures, convertible into ordinary shares, which will provide plant at the Kensington station capable of supplying houses wired for over 25,000 lamps, consuming 33 watts.

Parliamentary powers, under the Electric Lighting Acts, 1882-1888, giving the Company 42 years' tenure in a wealthy residential district at Kensington, have been granted to the Company. The district contains:—

District.	South.	North.	Total.
Private houses	5,734	7,120	12,854
Shops	642	1,608	2,250
Churches and chapels	15	24	39
Hotels and public houses	39	66	105
Public buildings, including Board schools	4	10	14
Rateable value	£573,097	£368,274	£941,371

Since these powers have been granted and the supply mains laid, there has been a steady increase in the Company's business. The Company's mains now extend throughout seven miles of the principal streets of the area allotted to the Company by Parliament, reaching the extreme end of the eastern and southern boundaries at Sumner-place and the Fulham-road respectively.

Since October 1, 1889 (the date the Company obtained power to lay supply mains in the public streets), orders for the supply of electricity have been received at the rate of about 400 lights per week, making at present a total of over 12,000 lights. The number of lights at present connected to the Company's mains is about 7,000, and the revenue from these lights already covers the whole of the working expenses, and the depreciation and establishment charges; so that a considerable profit will accrue when the extension of the lighting is brought up to the full power of the plant, as no further capital expenditure will be required, and the cost of producing the current will be relatively much reduced.

The net revenue from the station (including the additional unit of plant for which capital has been provided) when in full work, is calculated at £8,000 per annum, after allowing £7,000 per annum for working expenses, depreciation, &c.

PATENT
SILICIUM BRONZE AND SILICIUM COPPER WIRE.
The best for overhead Telephone and Telegraph Lines,
AND ALL ELECTRICAL PURPOSES.
Hard Drawn High Conductivity Copper Wire.
ROLLED AND DRAWN
PHOSPHOR BRONZE.
PHOSPHOR BRONZE
BEARINGS, BUSHES,
AND OTHER PARTS OF
ELECTRICAL MACHINERY.
SOLE PROPRIETORS of the British, Indian and Colonial Patents,
THE PHOSPHOR BRONZE COMPANY (Limited),
87, Sumner Street, Southwark, London, S.E.
WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

Digitized by Google

After giving a list of the present installations of the Company, the report continues:—

The Central Electric Lighting station which has been erected by the Company at Kensington is generally admitted to be the most perfectly equipped Central Electricity Supply station that has yet been erected. The machinery is divided into three units of plant, each capable of producing electricity for 3,000 33-watt incandescent lamps burning at one time. The station is designed for 12 of such sets of plant, with a capacity for supplying about 100,000 lamps, installed in about 2,000 houses, and it is the Directors' intention to issue further capital from time to time to provide for laying down the additional units, as the business of the Company extends.

The excellency of the engineering work done by the Company in planning and laying down the Kensington Station is so generally recognised, that the Directors are continually receiving enquiries from Supply Companies and Local Authorities throughout the United Kingdom, with a view to their contracting for laying down similar electric lighting stations elsewhere.

The following is a list of the Companies which have been registered by this Company, and of which this Company holds the whole of the founders' shares, entitled to half the profits after 7 per cent. has been paid on the respective capitals:—The Lancashire and Cheshire, the Yorkshire, the Northern, the Liverpool, the Birmingham, the Manchester, the Midland, the Western, the South of England, the Scottish, and the Irish House-to-House Electricity Companies (Limited). The Company holds a portion of the founders' shares in the following Companies:—The Devon and Cornwall Electricity Supply Company (Limited); the Portsmouth and South Hants Electricity Supply Company (Limited); the Sunderland and District Electricity Supply Company (Limited).

[Lists follow of the provincial towns and London parishes for which these Companies are applying for Provisional Orders.]

As favourable business arises in connection with these Provisional Orders, further issues of capital will be made.

The increasing favour with which householders are regarding the use of the electric light affords a field for the operations of the Company which is practically unlimited, and the moderate capital upon which the Company has to pay a dividend bears marked contrast to the capital of other companies seeking for similar business. Moreover, this Company has an immense advantage in being able to show a sample of its work in successful operation, and in having at its command the services of engineers who have been connected with House-to-House Electric Lighting from central stations from the beginning.

The retiring Directors are Mr. Henry Ramié Beeton and Mr. Robert Hammond, who, being eligible, offer themselves for re-election.

The auditors, Messrs. Theobald Bros. and Miall also retire, and offer themselves for re-election.

Submarine Cables Trust.

The following is the report of the Trustees to the nineteenth ordinary annual meeting of the certificate holders, to be held at the offices, 50, Old Broad-street, E.C., on Wednesday, the 7th inst. at one o'clock.

The revenue for the financial year to April 15, 1890, including the balance of £165. 1s. 6d., brought from the previous accounts, amounted to £23,259. 6s. 10d.

The coupon due on October 15, 1888, was paid in two instalments, viz., £2. 12s. 6d. on April 15, 1889, and the balance of 7s 6d. on May 15th last. The first payment of £2. 12s. 6d. was included in the previous year's accounts, but the balance of 7s. 6d. was a charge against the revenue for the past year. The expenses of the Trust amounted to £1,274. 0s. 5d., and the payments on account of the coupons to £21,553. 17s. 6d., together £22,827. 17s. 11d., leaving a balance of £431. 8s. 11d. to be carried forward. In addition to paying the 7s. 6d. outstanding on the October, 1888, coupons, the coupons due on April 15th and October 15th, 1889, have been met in full out of the revenue for the past year. The certificate holders have thus received interest at the rate of 6¾ per cent. in the past year, as against 5§ in the previous year. The coupons due on April 15, 1890, are in arrear, and will be paid as soon as the Trustees have sufficient money in hand for the purpose.

The Trustees regret the loss sustained in October last by the death of Sir Daniel Gooch, Bart., who was connected with the Trust since its formation. The Trustees do not recommend that the vacancy thus occasioned in their number be filled up, the remaining Trustees being quite competent to manage the Trust. An appreciable saving in the expenses will thereby be effected.

The meeting will have to elect two auditors for the current year; Mr. John G. Griffiths and Mr. John Gane offer themselves for re-election.

NEW COMPANIES REGISTERED.

J. A. EGESTORFF AND COMPANY (LIMITED).—Objects: To acquire and carry on the business of colour manufacturers, in all its branches, tin manufactures, electrical engineers miners, mine owners, and mineral works, and particularly that of Messrs. Egestorff and Son, of Backbarrow, in the county of Lancaster, adopting therefor an agreement made April 17, 1890, with Johannes Augustus Egestorff, of Backbarrow House, for the sale of the said business, and the properties connected therewith, for the sum of £3,800, of which £800 is to be paid in cash, and the residue in shares of the company. Capital, £10,000, in £5 shares. With few exceptions, the regulations contained in Table A apply. First managing director, the said Johannes Augustus Egestorff, at a remuneration of £400 per annum. Registered, April 24, by Waterlow and Sons (Limited), London-wall, for Salmon, Daniell, and Major, solicitors, Ulverston.

VENEZUELA TELEPHONE AND ELECTRICAL APPLIANCES COMPANY.—Objects: To carry on the businesss of telephone and telegraph companies in the Republic of Venezuela and elsewhere, and act as contractors for the supply of electricity for lighting and other purposes. Capital £70,000, in £1 shares. Borrowing limit £70,000. Registered, April 22nd, by Ashurst, Morris, Crisp, and Co., solicitors, 6, Old Jewry, London.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The receipts of this Company for the week ended April 25 amounted to £4,709.

BRITISH GUIANA ELECTRIC LIGHTING AND POWER COMPANY (LIMITED).—This Company has recently been floated, with a capital of $50,000 in 2,000 shares of $25 each, 1,000 only of the shares being offered for subscription under the present prospectus. The directors are: Messrs. Jacob Conrad, Chairman; Hon. B. Howell Jones, Arthur Braud, Arthur Weber, John Braud, E. T. White, M. Gonsalves. The consulting electrician is Mr. Samuel Vyle, and the secretary *(pro tem.)*, Mr. Thomas Watt. The Company has been formed to carry on in this colony public and private electric lighting and the supply of power for railroad, car, and other purposes, on the Thomson-Houston system. It is intended to commence operations for the lighting of private residences, churches, public institutions, places of business, and so on; and that the supply shall be furnished through meter or at fixed rates per lamp. The Directors congratulate the new Company on having secured the services of Mr. Vyle, who has had considerable experience in electric lighting, and whose complete scientific and practical knowledge is a guarantee to the British public for the efficient carrying out of the objects for which the new Company has been formed.

CONSOLIDATED TELEPHONE CONSTRUCTION AND MAINTENANCE COMPANY.—The Directors of this Company recommend a further dividend of 3½ per cent., making a total of 6 per cent. for the past year.

LONDON PLATINO-BRAZILIAN TELEGRAPH COMPANY (LIMITED).—A meeting of the shareholders of this Company was held yesterday (Thursday), but, the proceedings being private, no reporters were admitted.

SWAN UNITED ELECTRIC LIGHT COMPANY.—The Directors of this Company have decided to pay an *ad interim* dividend at the rate of 6 per cent. per annum for the six months ended March 31, 1890, to be distributed in accordance with the Articles of Association.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended April 25th, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,652.

THE NON-CONDUCTOR OF ELECTRICITY.

WAREHOUSE.

VULCANISED FIBRE,

PATENTED.

This new material is supplied in two qualities, Flexible and Hard.

The FLEXIBLE is a substitute for Leather, Rubber, Gutta Percha, &c., and is extensively used by Brass Founders, Axle Makers, Hydraulic, Sanitary, and other Engineers, Pump Makers, Carriage Builders, &c.

It makes the best Hot and Cold Water Packings, and for Axle Washers of all kinds it is unequalled.

The HARD is a substitute for Metals, Hard Wood, Ivory, Vulcanite, Ebonite, &c., and is a good Insulator.

Sold in sheets, 5ft. 6in. by 3ft. 6in., varying in thickness from 1-60in. to 1in.

FLEXIBLE, 2/- per lb.; HARD, 2/3 per lb.

FACTORY.

MOSSES & MITCHELL, 70 Chiswell-st., London, E.C.

Digitized by Google

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, April 23.	Price Wednesday, April 30.	Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending April 30. Highest.	Lowest.
£			**TELEGRAPHS.**			£ s. d.			
1,770,360	Stock	15/0	Anglo-American	49 50	50 51	5 7 10	Jan., Apr., July, Oct.	51	49½
2,614,820	Stock	30/0	Do. Preferred	83½ 84½	85 86	6 7 11	,, ,,	86¼	83¾
2,614,820	Stock	..	Do. Deferred	14½ 15	15½ 16	..	February	16⅛	14½
..	£100	..	African Direct, 4 per Cent. Debentures	98 101	98 101	3 19 3	..	..	..
130,000	10	3/0	Brazilian Submarine	12½ 12¾	12½ 12¾	5 17 8	Mar., June, Oct., Dec.	12⅞	12½
112,900	100	5%	Do. 5 per Cent. Bonds	100 102	101 103	4 17 1	January and July	..	..
75,000	100	5%	Do. 5 per Cent. Bonds (2nd Series)	105 108	105 108	4 12 7	June and December	..	..
16,000	10	9/0	Cuba Submarine	11 11½	11 11½	7 16 6	February and August	11½	11½
6,000	10	10%	Do. Preference 10%	17½ 18½	17½ 18½	5 8 1	,, ,,	..	..
12,931	5	2/4½	Direct Spanish (£4 paid)	3¾ 4¼	3⅝ 4¼	5 3 6	March & September	..	..
6,000	5	10%	Do. Preference 10%	9 10	9 10	5 0 0	April and October	..	..
60,710	20	3/6	Direct United States	10½ 10⅝	10½ 10⅝	6 14 11	Jan., Apr., July, Oct.	10⅞	..
880,000	10	2/6	Eastern	14⅛ 14⅜	14⅛ 14⅜	4 10 5	,, ,,	14⅜	14⅜
70,000	10	6%	Do. 6 per Cent. Preference	14¼ 15¼	14¾ 15¼	3 18 8	,, ,,	15	14¼
1,200,000	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock.. xd	108 110	106 108	3 14 1	May and November	110	107½
200,000	£100	5%	Do. 5 per Cent. Debentures, 1899	106 109	106 109	4 11 9	February & August	..	..
250,000	10	2/6	Eastern Extension xd and bonus	14⅛ 14¾	14⅛ 14⅜	4 17 5	Jan., Apr., July, Oct.	14¾	14⅛
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	100 102	100 102	5 17 8	February & August	..	..
473,000	100	5%	Do. 5 per Cent. (Austn. Gov. Sub.) Debs. 1900	103 106	103 106	4 14 4	January and July	..	..
367,900	100	..	Eastern & S. African 5 per Cent. Mor Deb., 1900..	101 104	102 105	4 15 3	..	103¼	102½
179,177	10	1/9	Globe Telegraph and Trust	8¾ 9	8⅞ 9⅛	5 18 2	Jan., Apr., July, Oct.	9⅛	8⅞
178,992	10	6%	Do. 6 per Cent. Preference	14¾ 15	14¾ 15⅛	3 19 5	,, ,,	15	14¾
150,000	10	5/0	Great Northern xd	15½ 16	15⅝ 16	4 13 6	Jan., July, and April	16	15⅝
..	100	..	Do. 5 per Cent. Debentures, 1881	102 105	102 105	4 15 3	..	..	..
..	100	..	Do. 5 per Cent. Debentures, 1883	104 107	104 107	4 13 6	..	106	104¾
17,000	25	12/6	Indo-European xd	40 42	38 40	6 5 0	April and October	41¾	..
..	10	..	London Platino-Brazilian	6 7	6 7	6 15 9	..	..	..
..	100	..	Do. 6 per Cent. Debentures	106 109	107 110	5 9 1	..	..	..
9,000	8	4/0	Reuter's xd	7¾ 8¼	7⅞ 8	5 0 0	April and October	7⅛	..
..	Cert.	..	Submarine Cables Trust	110 115	110 115	5 4 4	..	112	..
15,609	£10	3/6	West African	9½ 10½	9⅝ 10¼	..	..	..	..
300,000	100	5%	Do. 5 per Cent. Debentures	99 102	99 102	4 18 0	March & September	100½	..
30,000	10	5/0	West Coast of America	9½ 10½	8 9	5 11 1	January and July	8⅞	8
150,000	100	8%	Do. Debentures 8%	121 126	121 126	6 7 0	June and December	122	..
88,321	10	Nil.	West India and Panama	2⅞ 3⅛	2⅝ 2⅞	..	..	3	2⅝
34,563	10	12/0	Do. 1st Preference 6%	11½ 12	11½ 12	5 0 0	April and October	12	11⅞
4,669	10	10/0	Do. 6 per Cent. 2nd Preference	14 15	14 15	4 0 0	..	14⅞	14⅛
45,181	15	6/0	Western Brazilian	10½ 11	10½ 11	6 17 0	May and November	10⅞	10⅝
..	7½	..	Do. 5 per Cent. Cumulative Preferred	6½ 6¾	6⅝ 7	..	..	6⅞	6⅝
..	7½	..	Do. 5 per Cent. Deferred	4½ 4¾	4½ 4⅝	..	..	4¾	..
..	100	..	Do. 6 per Cent. Debentures, Series "A"	106 109	106 109	5 10 1	..	..	..
..	100	..	Do. 6 per Cent. Mort. Debentures, Series "B"	104 107	104 107	5 12 2	..	..	..
$1,500,000	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	122 126	122 126	5 11 1	May and November	..	..
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	99 101	99 101	5 18 10	March & September	..	..
			TELEPHONES.						
224,850	14/0	5%	Consolidated Telephone and Maintenance	⅞ 1	⅞ 1	..	Yearly	1⅛	..
220,000	£1	3%	Oriental (11s. paid) xd	½ ⅝	½ ⅝	4 8 3	..	..	..
80,000	5	2/0	National	5⅜ 5⅝	5¼ 6¼	..	June and December	6¼	5¼
..	5	..	Do. New	4 4½	4½ 5	..	..	..	..
..	10	..	Do. 6 per Cent. Cumulative 1st Preference	12¼ 12⅝	12¼ 12⅝	4 14 1	..	12⅞	..
..	10	..	Do. 6 per Cent. Cumulative 2nd Preference	10 11	10 11	5 9 1	..	10⅝	..
..	1	..	South of England, Ordinary	½ ⅝	½ ⅝	..	..	..	..
..	5	..	Do. 6 per Cent. Cumulative Pref. (£3 10 paid)	3½ 3⅝	3½ 3⅝	6 0 0	..	..	..
55,000	5	3/0	United River Plate	4½ 5	4⅝ 5	..	January and July	..	..
..	Stock	..	Do. 5 per Cent. Debenture Stock	90 94	90 94	5 6 5	..	..	..
			ELECTRICITY SUPPLY COMPANIES.						
555,000	£5	..	London Electric Supply	2⅝ 2⅞	2⅝ 2⅝	..	..	..	..
500,000	10	..	Metropolitan Electric Supply (£6 paid)	5½ 6	5½ 5⅝	..	..	..	..
..	5	..	Westminster Electric Supply Corporation	1½ 2	1⅝ 2	..	..	..	..
			ELECTRIC MANUFACTURING, &c., COMPANIES.						
190,248	3	..	Brush Electrical Engineering	2½ 2⅝	2½ 2⅝	..	..	2⅝	2⅝
..	2	..	Do. Preference	1⅝ 1⅞	1⅝ 1⅞	..	..	1⅞	1⅞
..	5	..	Crompton and Co., 7 per Cent. Preference Shares.	5½ 5¾	5½ 5¾	6 1 9	..	..	..
353,478	5	7%	Edison and Swan United	.. ..	.. ..	..	..	..	..
409,000	10	..	Electric Construction	9⅜ 10¼	9⅜ 10¼	..	..	..	..
140,000	2	..	Elmore's Patent Copper Depositing	4¼ 5¼	5¼ 5⅜	..	..	5⅜	5¼
..	5	..	Fowler-Waring Cables	2¼ 2⅜	2¼ 2⅜	..	..	..	..
41,600	10	10/0	India Rubber, Gutta Percha & Telegraph Works..	18 19	18 19	5 5 3	February & August	18½	18¼
..	100	..	Do. 4½ per Cent. Debentures, 1896	101 104	103 105	4 5 9	..	..	..
78,949	5	6%	Swan United (£3. 10s. paid) xd	4½ 5	4¼ 4⅜	..	..	4⅝	..
37,350	12	36/0	Telegraph Construction and Maintenance	44 46	44 46	5 3 11	March and July	45¼	45
..	100	..	Do. 5 per Cent. Bonds, red. 1894	101 104	101 104	4 16 2	..	..	..

JABLOCHKOFF'S DISTRIBUTION PATENT

(BEING A PATENT FOR "PRODUCING AND DIVIDING ELECTRIC LIGHT," No. 1996 of 1877.)

THE ELECTRICAL ENGINEERING CORPORATION, LIMITED

(STATTER'S) Are Proprietors of the above Patent, and Warn the Public against Infringement. (UNITED).

The following are Licensees:—

Brush Electrical Engineering Company, Limited.
Crompton & Co., Limited.
S. Z. de Ferranti.—London Electric Supply Corporation, Limited.
M. T. Goolden & Co.
Hammond & Co.
Wilson Hartnell.
Johnson & Phillips.
Laurence, Paris & Scott, Limited.
Nalder Brothers & Co.
Paterson & Cooper.
Ernest Scott & Co.
Siemens Brothers & Co., Limited.

3, Prince's Mansions, Victoria Street, Westminster. PERCY E. SCRUTTON, *Secretary.*

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

32101 050973120

Digitized by Google